MILITARY FIELD NOTE BOOK

GUILD *and* COTTON

1917

GEORGE BANTA PUBLISHING COMPANY
MENASHA, WISCONSIN

MILITARY FIELD NOTE BOOK

BY

Captain GEORGE R. GUILD and Lieutenant ROBERT C. COTTON

United States Army

Second Edition

Adapted for the Use of the
OFFICERS and ENLISTED MEN
of the
FORCES OF THE UNITED STATES

This Note Book is carried on the
War Department list of Private Publications
for issue to troops

The Collegiate Press
GEORGE BANTA PUBLISHING COMPANY
MENASHA, WISCONSIN

1917

Dedicated

to those of the military profession who must carry a notebook in the field, with the hope that this little volume may assist them in ascertaining the information they desire when no other reference books are available

ADVICE TO OWNER: Learn what your book contains, and just where to find what you want—it will save you time when you need a thing in a hurry

PRICE, 75 CENTS
(Waterproof cover, 15 cents extra)
(Extra fillers, 10 cents)

GENERAL INDEX

PERSONAL DATA

Name .....

Rank ..... U. S. Army

W. D. Code Name..... Signal Number.....

Disbursing Number.....

Born at..... year.....

Height..... ft. ..... ins; weight..... lbs.

Married or single.....

Number of minor children.....

Person to notify in case of death or severe injury.....

.....

Banks in which I have accounts:—

Bank..... City.....

Bank..... City.....

Bank..... City.....

Insured as follows:—

Company .....

No. of Policy.....; Amt. of Policy, $.....

Amt. of Premium, $.....; Due.....

Name of Beneficiary.....

Company .....

No. of Policy.....; Amt. of Policy, $.....

Amt. of Premium, $.....; Due.....

Name of Beneficiary.....

Watch: Make.....; kind.....

No. of Works.....; No. of Case.....

Pistol: Kind.....; Number.....

Field Glasses: Kind.....; Number.....

Paces: Number I take to 100 yards.....

Distance horse walks in 10 minutes.....

Distance horse trots in 10 minutes.....

Distance horse gallops in 10 minutes.....

No. of minutes horse to walk one mile.....

No. of minutes horse to trot one mile.....

No. of minutes horse to gallop one mile.....

Miscellaneous data.....

.....

.....

(Note:—Entries that are liable to frequent change, record in pencil.)

Sizes of Garments:—

Hat.....; Shoes, No. ..... size.....last; Collars.....; Cuffs.....;

Blouse, No. .....; Trousers.....; Breeches.....; Leggins.....;

Socks.....; Undershirts.....; Drawers.....; Woolen Shirt.....;

White Shirts.....; Boots.....; Overcoat.....; Slicker.....;

.....; .....; .....

.....; .....; .....

No. of Rifle.....; No. of Bayonet.....

MY WILL

I, ..., U. S. Army, being of full age, and sound and disposing mind and memory, do hereby make, publish, and declare this to be my last will and testament.

First. I direct all my just debts and funeral expenses be paid as soon as possible after my decease.

Second. I do hereby give, devise, and bequeath, absolutely, and to his, hers, and their heirs and assigns forever, the following moneys, properties, values, etc., as shown after the respective names, to wit:

To .....

.....

.....

I do hereby nominate, constitute, and appoint, without bond, ...

..... sole executor of this my last will and testament. I hereby revoke all other or former wills or testaments by me made.

IN WITNESS WHEREOF, I have hereunto subscribed my name and set my seal this.....day of....., in the year one thousand nine hundred and .....

(Seal) .....
(name)

....., U. S. Army.
(rank)

The foregoing instrument was on this ..... day of..... in the year one thousand nine hundred and ....., subscribed, sealed, made, published, and declared by the testator therein named,

....., as and for the
(name of testator)
last will and testament of said testator in our presence, whereupon at the request of said testator and in his presence and in the presence of each other, we have signed our names at the end hereof as attesting witnesses thereto this ..... day of ....., in the year one thousand nine hundred and .....

....

..... U. S. Army. ..... U. S. Army.

Note:—If the above is not made out my will can be found at.....

.....

ASSIGNMENT OF "SIX MONTHS' PAY," PER ACT OF MAY 11, 1908

Note:—This designation, if properly witnessed by the next superior commander (or other officer, in emergency) and one other person, will hold in law as the last designation of the person signing if such person, for any reason, sees fit to change his beneficiary in the field in time of hostilities without means at hand of notifying the War Dept. Leave it in your notebook, and, if anything should happen to you, friends will find it.

DESIGNATION

I, ... (full name of designator)

a ..... (rank) of ..... (branch of service)

on the active list of the Army of the United States, born on the.....

day of ....., 19...., in ..... (city or town)

..... and ..... (appointed or enlisted) on the ..... day

of ....., 19...., do hereby designate .....

..... (full name of first beneficiary)

who is my..... (relationship, if any) and whose address is.....

..... (give complete address)

....., as the person to whom shall be paid the six months' pay authorized by the Act of Congress approved May 11, 1908, as amended by the Act of March 3, 1909, in the event of my death from wounds or disease not the result of my own misconduct.

And I do hereby further designate..... (full name of alternate

....., who is my ..... beneficiary)

and whose address is.....

..... (give complete address)

as my beneficiary in the event of the death of the first beneficiary prior to the date of payment of the gratuity. The designations hereon revoke any and all previous designations for the like purpose.

(Signature) .....

(Rank) .....

Subscribed in our presence this ..... day of ....., 19....

at ..... (location)

Witnesses:—

(Signature) ..... (Signature) .....

(Rank) ..... (Rank) .....

RECORD OF DETACHED SERVICE

Instructions:—The number of days present with troops plus the number of days NOT present with troops during any period must equal the actual total number of days in that period; this is a check on the computations, being careful of leap years. To determine eligibility:—Count back 730 days (2 years) from any date under the heading "Days actually present for duty with troops": If the date upon which the 730th day falls is within the past 6 years the officer is eligible for D. S. and can remain on D. S. until 6 years from that date. The day of departure and the day of return are both days of D. S. For those departments which require only ONE YEAR with troops, use 365 instead of 730. If a year is divisible by 4 but not by 400, February of that year contains 29 days.

Days Actually Present for Duty with Troops

MONTH	19...	19...	19...	19...	19...	19...	19...	19...	19...
Jan.									
Feb.									
Mar.									
Apr.									
May									
June									
July									
Aug.									
Sept.									
Oct.									
Nov.									
Dec.									
Total									

MONTH	19...	19...	19...	19...	19...	19...	19...	19...	19...
Jan.									
Feb.									
Mar.									
Apr.									
May									
June									
July									
Aug.									
Sept.									
Oct.									
Nov.									
Dec.									
Total									

Days NOT Actually Present for Duty with Troops

Year	Months	Dates	No. of Days	Cause	Year	Months	Dates	No. of Days	Cause

Days NOT Actually Present for Duty with Troops

Year	Months	Dates	No. of Days	Cause	Year	Months	Dates	No. of Days	Cause

TARGET PRACTICE QUALIFICATIONS

Year	Qualification	Place	Date of Qual.	Total Points	Rifle or Pistol

IMPORTANT ORDERS AFFECTING FIELD SERVICE

LEAVES OF ABSENCE

Leave	From:—			To:—			Total		Per S. O.
Year	Yr.	Mo.	Day	Yr.	Mo.	Day	Mos.	Days	No.

IMPORTANT ADDRESSES AND TELEPHONES

Name..... Phone.....

Address .....

.....

Name..... Phone.....

Address .....

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Name..... Phone.....

Address .....

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Name..... Phone.....

Address .....

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Name..... Phone.....

Address .....

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Name..... Phone.....

Address .....

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ADDRESSES OF MILITARY DEALERS

Army and Navy Journal, 20 Vesey St., New York City.
Army and Navy Register, 511 11th St. N. W., Washington, D. C.
Army Mutual Aid Assn., 504 Colorado Bldg., Washington, D. C.
Brooks Brothers, Military Outfitters, Broadway, Cor. 22nd St., New York City.
B. Pasquale Co., Military Outfitters, 115 Post St., San Francisco.
Bausch & Lomb Optical Co., Rochester, N. Y.
C. P. Goerz, American Optical Co., 317 East 34th St., New York City.
Ernst Leitz, Optical Goods, 30 East 18th St., New York City.
F. J. Heiberger & Son, Inc., Military Outfitters, 1419 F St. N. W., Washington, D. C.
Geo. Banta Publishing Co., Military Books, Printing, and Simplex and "G. R. G." Blank Forms, Menasha, Wis.
Henry V. Allien & Co., Military Outfitters, 734 Broadway, New York City.
The Henderson Ames Co., Military Outfitters, Kalamazoo, Mich.
Infantry Journal, Union Trust Building, Washington, D. C.
Journal of the Military Service Institute, Governor's Island, New York Harbor.
Journal of the U. S. Field Artillery Assn., Washington, D. C.
Journal of the U. S. Cavalry Assn., Fort Leavenworth, Kan.
John G. Haas, Military Outfitters, 1308 F St. N. W., Washington, D. C.
The M. C. Lilley & Co., Military Outfitters, Columbus, Ohio.
Mills Woven Cartridge Belt Co., Woven Webb Equipments, 70 Webster St., Worcester, Mass.
Meyers Military Shop, Military Outfitters, 1231 Pennsylvania Ave. N. W., Washington, D. C.
Rosenwasser Brothers, Leggins, 472 Broadway, New York City.
Rudolph Wurlitzer Co., Band Instruments, 117 East 4th Ave., Cincinnati, Ohio.
R. Springe, Military Outfitters, Leavenworth, Kan.
Sigmund Eisner, Military Tailor, Red Bank, N. J.
Warnock Uniform Company, Military Outfitters, 19 West 31st St., New York City.
William H. Horstman Company, Military Outfitters, Philadelphia, Pa.
W. & L. E. Gurley, Mathematical Instruments, Troy, N. Y.

OFFICERS' CAMP EQUIPMENT—Reminder, guide only

TOILET ARTICLES:—Basin; brush, hair; brush, nail; brush, tooth; bucket; comb; housewife; nailfile; soap; soap-box; shaving outfit; tooth powder; talcum powder; toilet paper; towels, face; towels, bath; mirror.

CLOTHING:—Extra underwear; extra outer clothing; extra socks; extra leggins; extra shoes; extra shoe strings; extra O. D. shirt; sweater; overcoat; raincoat; rubber boots; slippers; gloves.

BED ROLL:—The roll; clothing bag; Q. M. cot; blankets; comforter; sheets; mattress; pillow; pillow-case; mosquito bar; head net; bath towel; soap; candle; matches; change underclothes.

MESS EQUIPMENT:—Meat can; knife; fork; spoon; tin cup;—or mess chest.

HORSE EQUIPMENT:—Saddle; saddle bags; bridle; halter; lariat; picket pin; watering bridle; surcingle; horse cover; nosebag; spurs; gloves; dispatch case; grain bag; pommel pockets.

MISCELLANEOUS:—Writing paper; envelopes, personal and official; stamps; blotter; rope; note book; compass; watch; cork screw; can opener; pocket knife; camp stools; clothes hooks; candles; lantern; matches; tobacco; pencils; handle-with-tools; check book; scale of paces; Drill Regulations; Army Regulations; Field Service Regulations; Court Martial Manual; money; string; nails; medicine case; oil stove; can of coal-oil; fountain pen; pay vouchers; whiskey flask; message blanks, official, W. U., and Postal; camp table; message book; flash lamp; kodak; playing cards; reading matter.

BED ROLL:—Size, 39" long by 21" in diameter.

FIELD BOX:—Size, 32" x 19" x 13" and must be made with handles of leather or other similar material, and hinges and locks, or clasps, must be flat, and as nearly flush with the box as possible. An enlisted man's trunk locker meets these requirements.

Individual Personal Equipment to be in the possession of each man, except articles marked (x), which will be kept in the company storeroom.

1 bar, mosquito
1 bed sack (x)
2 blankets
1 belt, waist
2 breeches, pairs
chevrons (1 set per garment)
1 cord, hat
3 drawers
1 hat, service (with tie cord)
2 laces, shoes, extra
1 leggins, leather
2 shirts, O. D.
2 shoes, marching
4 stockings, pairs
1 tag, identification, and tape
3 undershirts
1 cot (x)
1 head net (x)
5 pins, tent, shelter
1 pole, tent, shelter
1 (poncho) or slicker
2 shoes, horse (x)
1 tent, shelter half, mtd. or dismtd.

FIELD KIT

Toilet Articles:—
1 comb
1 soap, cake
1 soap, box
1 brush, tooth
1 brush, tooth, holder
1 towel, face

Clothing Component:—
1 blanket
1 drawers, pair
1 poncho (mtd. or dismtd.)
1 slicker (mtd. men)
2 stockings, pairs
1 undershirt

Tentage:—
1 shelter tent (mtd. or dismtd.)
1 shelter tent pole, mtd.
5 shelter tent pins

SURPLUS KIT

Components:—
1 breeches, pair
1 drawers, pair
1 shirt, O. D.
1 shoes, pair with laces
2 stockings, pairs
1 laces, shoe, extra
1 undershirt

SQUAD EQUIPMENT

Components:—
1 surplus kit bag
8 "surplus kits" complete
2 pkgs. toilet paper
1 can foot powder
1 Housewife:—
(1 scissors, pr.
3 needles, large
24 needles, asstd.
28 pins
8 safety pins
1 card thread, white, black, O. D.
24 buttons, O. D. shirt
48 buttons, underwear.).

BARBER KIT (not exceeding 8 lbs.)

Components:—
2 brushes, shaving
2 cups, shaving
6 razors
2 straps, razor
2 clippers
1 hone
2 scissors
12 towels

CHANGES

Values of Π:—

$\Pi = 3.1415926536.$ $\log \Pi = 0.4971499.$ $\frac{\Pi}{3} = 1.0472.$

$\Pi^2 = 9.86960.$ $\frac{360}{\Pi} = 114.59$ $\frac{\Pi}{4} = 0.7854.$

$\Pi^3 = 31.00628.$ $\log \sqrt{\Pi} = 0.2485749.$ $\frac{\Pi}{12} = 0.2618.$

$\sqrt{\Pi} = 1.77245.$ $\Pi = \frac{22}{7}$ (roughly). $\frac{\Pi}{64} = 0.04909.$

$\frac{1}{\Pi} = 0.31831.$

$\frac{1}{\Pi^2} = 0.10132.$ $\frac{\Pi}{2} = 1.5708.$

$\sqrt{\frac{1}{\Pi}} = 0.56419.$

Circle:—

Equation is $x^2 + y^2 + 2gx + 2fy + c = 0.$

Diameter × 3.1416 = Circumference.

Diameter × 0.886277 = Side of a square of equal area.

Diameter × 0.7071 = Side of an inscribed square.

Diameter squared × 0.7854 = area.

Diameter = Square root of area × 1.1283.

Circumference × 0.31831 = diameter.

Circumference × 0.2821 = Side of a square of equal area.

Circumference × diameter × 0.25 = area.

Radius × 6.2832 = circumference.

Radius squared × 3.1416 = area.

Radius × 0.017453 = Length of an arc of 1 degree.

Radius × 0.0002909 = Length of an arc of 1 minute.

Radius × 0.0000048 = Length of an arc of 1 second.

Length of arc = Number of degrees × 0.017453 × radius.

One radian is a length of arc equal to the radius, and is 57° 17′ 45″ = 57.2958°.

Radians = Number of degrees × 0.017453.

Area of a circle = 0.7854 × Square of diameter.

Area of a sector = Length of arc × radius × 0.5.

Area of a segment = Area of a sector of equal radius less area of triangle if segment is less than 180°.

Area of a segment = Area of a sector of equal radius plus area of triangle if segment is greater than 180°, or Area is equal to

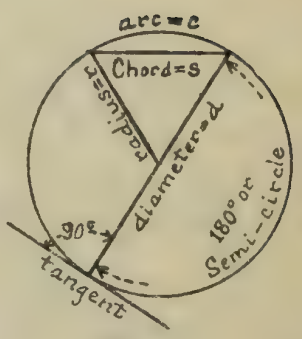


Fig. 1

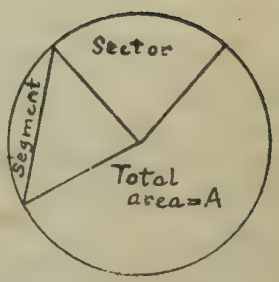


Fig. 2

$$\frac{4\,h}{3}\sqrt{0.388h^2 + \frac{25}{4}}$$ very nearly, for flat segments.

$$r = \frac{h^2 + \frac{S^2}{4}}{2\,h}$$ or very nearly $\frac{S^2}{8\,h}$

$$h = r - \sqrt{r^2 - \frac{S^2}{4}}$$ or very nearly $\frac{S^2}{8\,r}$

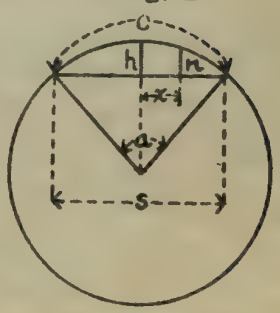


Fig. 3

$c = 0.17454\ a\ r$

$d = 1.12838\ \sqrt{A}$

$A = 0.7854\ d^2$

Circles are to each other as the squares of their diameters, or radii, or chords of equal arcs.

Square:—
Side of a square × 1.1284 = Diameter of a circle of equal area.
The square of any side = the area.
Length of a diagonal = square root of twice the square of one side.
Squares are to each other as the squares of their sides, or their diagonals.
Side of a square = diameter of inscribed circle; or diameter of circumscribed circle × 0.7071.
The diagonal of a square = any side × 1.4142; also = Side × 10, less 0.01 times this result from itself, divide by 7.
The side of the greatest square in a circle = Diameter of circle × 0.7, add 0.01 times this value to itself.

Parallelogram:—4 sided, opposite sides are parallel.
Refer to Fig. 4.
Area = a × h.

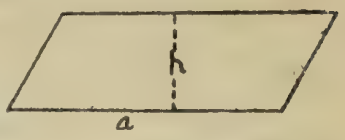


Fig. 4

Trapezoid:—4 sided, 2 sides being parallel.
Refer to Fig. 5.
Area = ½ (a + b) × h.

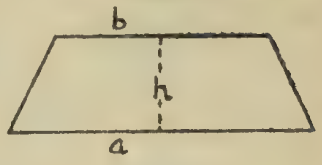


Fig. 5

Trapezium:—4 sided, no sides parallel.
Refer to Fig. 6.
Area is obtained by dividing figure into two triangles by diagonal e and adding area of triangles.

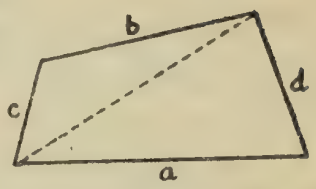


Fig. 6

Ellipse:—Equation is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.
Refer to Fig. 7.
Area = 0.7854 × product of diameters a′ and b′.

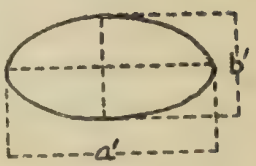


Fig. 7

Parabola:—Equation is $y^2 = 4\,a\,(x - a)$.
Refer to Fig. 8.
Area = 2/3 a′ × h′.

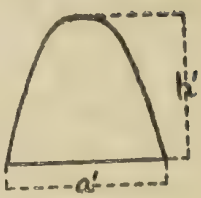


Fig. 8

Hyperbola:—Equation is $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$.

Hexagon:—(six sides).
Any side = the radius of a circumscribed circle.
Area = the square of any side × 2.598.

Octagon:—(eight sides).
Any side = radius of circumscribed circle × 0.7633.
Area = Square of any side × 4.8289.

Sphere:—
Area of surface = Square of diameter × 3.1416.
Cubical contents (volume) = Cube of diameter × 0.5236.
Dimensions of a cube of equal volume = diameter × 0.806.
Length of a cylinder of equal volume = 2/3 of diameter when base has same diameter as sphere.

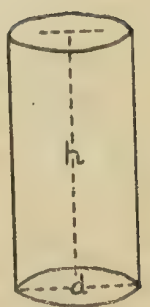


Fig. 9

Surface of a sphere $= 4 \Pi r^2 = 12.5664 r^2 = 3.1416 d^2$ $= 0.3183$ circumference squared $= 4 \times$ area of a great circle $=$ diameter $\times$ circumference $=$ the curved surface of a circumscribed cylinder.

The surfaces of two spheres are to each other as their corresponding lines.

The volume of a sphere $= 4/3 \Pi r^3 = 4.1888 r^3 = 0.5236 d^3 = 0.01689$ circumference cubed $= 2/3$ diameter $\times$ area of a great circle $= 2/3$ volume of a circumscribed cylinder $= 0.5326$ volume of a circumscribed cube.

The volumes of spheres are to each other as the cubes of their corresponding lines.

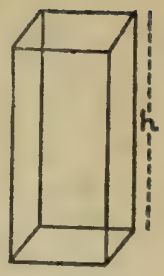


Fig. 10

Cubes:—

Area $= 6 \times$ area of each face.
Volume $=$ cube of any edge.
The diagonal $=$ edge $\times$ 1.7321.

Cylinder; Prism:—

Refer to Figs. 9 and 10.
Area of convex surface (not including ends) $=$ perimeter of base $\times$ altitude (h).
Volume $=$ Area of base $\times$ altitude (h).

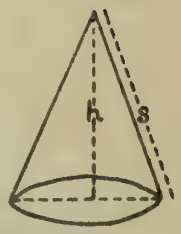


Fig. 11

Pyramid; Cone:—

Refer to Fig. 11.
Area of convex surface (not including end) $=$ perimeter of base $\times$ ½ slant height (s).
Volume $=$ Area of base $\times$ 1/3 altitude (h).

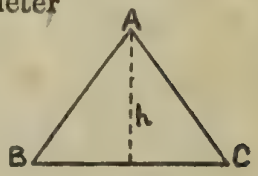


Fig. 12

Triangles (plane):—

Equilateral (12), all three sides equal, $A = B = C$.
Isosceles (13), only two sides equal, $B = C$.
Acute angled (12), each angle less than 90°.
Obtuse angled (13), when one angle (A) is greater than 90°.
Right triangle (15), when one angle (C) $= 90°$.

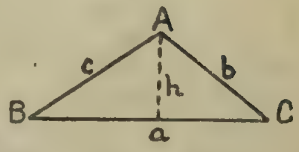


Fig. 13

Any triangle (refer to 12, 13, 14, or 15):—

The sum of the angles $= 180°$.
Complement of an angle $=$ its difference from 90°.
Supplement of an angle $=$ its difference from 180°.
The sides are directly proportionate to the sides of the opposite angles; the greatest and the least sides are opposite the greatest and the least angles.

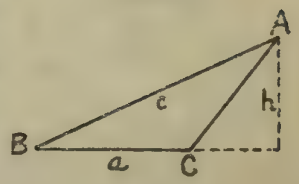


Fig. 14

The area $=$ ½ base $\times$ altitude, or $A =$ ½ a h.

$$\text{area} = \sqrt{s\ (s-a)\ (s-b)\ (s-c)}$$

$$\text{where } s = \frac{a+b+c}{2}$$

area $=$ any side $\times$ ½ the perpendicular distance from the opposite angle to that side (or prolongation of side).

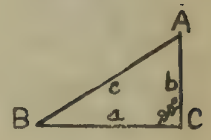


Fig. 15

A line bisecting one angle divides the opposite side into parts proportional to the adjacent sides. (Fig. 16.) $x : y :: c : a$.

Lines drawn from each angle to the middle of the opposite side intersect in a common point which is the center of gravity of triangle; and the shorter part of each line is one-half the longer part. (Fig. 16.) $V =$ ½ W.

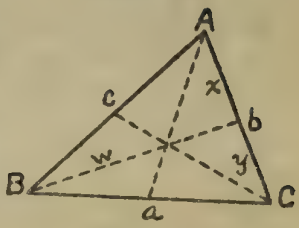


Fig. 16

Similar triangles differ only in the length of their sides, their respective angles being equal. Their sides must be parallel or perpendicular. (See Fig. 17.)
The ratio between corresponding sides is the same, i. e., a : b :: a′ : b′.

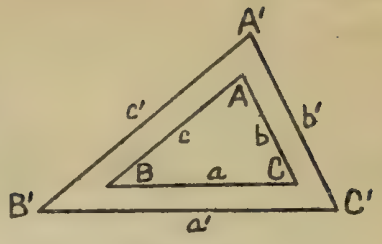


Fig. 17

Sine and Tangent Formulae:— (Refer to Fig. 18.)

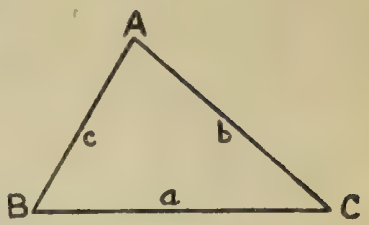


Fig. 18

$\text{Sin } (-B) = -\text{Sin } B.$
$\text{Sin } (90° + B) = \text{Cos } B.$
$\text{Sin } (180° - B) = \text{Sin } B.$
$\text{Sin } (180° + B) = -\text{Sin } B.$
$\text{Sin } (360° - B) = -\text{Sin } B.$
$\text{Sin } (360° + B) = \text{Sin } B.$
$\text{Sin } (B + A) = \text{Sin } B \text{ Cos } A + \text{Cos } B \text{ Sin } A.$
$\text{Sin } (B - A) = \text{Sin } B \text{ Cos } A - \text{Cos } B \text{ Sin } A.$
$\text{Sin } 2B = 2 \text{ Sin } B \text{ Cos } B.$
$\text{Sin } 3B = 3 \text{ Sin } B - 4 \text{ Sin}^3 B.$
$\text{Sin } \frac{1}{2}B = \sqrt{\frac{1}{2}(1 - \text{Cos } B)}.$
$\text{Sin}^2 B = \frac{1}{2}(1 - \text{Cos } 2B).$
$\text{Sin } B + \text{Sin } A = 2 \text{ Sin } \frac{1}{2}(B + A) \text{ Cos } \frac{1}{2}(B - A).$
$\text{Sin } B - \text{Sin } A = 2 \text{ Sin } \frac{1}{2}(B - A) \text{ Cos } \frac{1}{2}(B + A).$

$\text{Tan } (-B) = -\text{Tan } B.$
$\text{Tan } (90° + B) = -\text{Cot } B.$
$\text{Tan } (180° - B) = -\text{Tan } B.$
$\text{Tan } (180° + B) = \text{Tan } B.$
$\text{Tan } (360° - B) = -\text{Tan } B.$
$\text{Tan } (360° - B) = -\text{Tan } B.$
$\text{Tan } (B + A = (\text{Tan } B + \text{Tan } A) \div (1 - \text{Tan } B \text{ Tan } A).$
$\text{Tan } (B - A) = (\text{Tan } B - \text{Tan } A) \div (1 + \text{Tan } B \text{ Tan } A).$
$\text{Tan } 2B = (2 \text{ Tan } B) \div (1 - \text{Tan}^2 B).$
$\text{Tan } 3B = (3 \text{ Tan } B - \text{Tan}^3 B) \div (1 - 3 \text{ Tan}^2 B).$
$\text{Tan } \frac{1}{2}B = (1 - \text{Cos } B) \div \text{Sin } B.$
$\text{Tan}^2 B = (1 - \text{Cos } 2B) \div (1 + \text{Cos } 2B).$
$\text{Tan } B + \text{Tan } A = [\text{Sin } (B + A)] \div [\text{Cos } B \text{ Cos } A].$
$\text{Tan } B - \text{Tan } A = [\text{Sin } (B - A)] \div [\text{Cos } B \text{ Cos } A].$

Value of any angle, as A:—

$$\text{Sin } A = \frac{a \text{ Sin } C}{c} = \frac{a \text{ Sin } B}{b} = \text{Sin } (B + C)$$

$$\text{Sin } A = \text{Sin } B \text{ Cos } C + \text{Cos } B \text{ Sin } C$$

$$\text{Cos } A = \text{Sin } B \text{ Sin } C - \text{Cos } B \text{ Cos } C$$

$$\text{Cos } A = \frac{c^2 + b^2 - a^2}{2 \text{ bc}}$$

$$\text{Tan } A = \frac{a \text{ Sin } C}{b - a \text{ Cos } C} = \frac{a \text{ Sin } B}{c - a \text{ Cos } B}$$

$$\text{Tan } A = \frac{\tan B + \tan C}{\tan B \text{ n } C \text{ at} - 1}$$

Trigonometric relations, Fig. 19:—

$$\text{Sin} = \frac{1}{\text{cosec}} = \frac{\cos}{\cot} = \sqrt{(1 - \cos^2)}$$

$$\text{Cos} = \sqrt{(1 - \sin^2)} = \frac{\sin}{\tan} = \sin \times \cot = \frac{1}{\sec}$$

$$\text{Tan} = \frac{1}{\cot} = \frac{\sin}{\cos}; \quad \text{Cot} = \frac{1}{\tan} = \frac{\cos}{\sin}$$

$$\text{Sec} = \frac{1}{\cos} = \frac{\tan}{\sin} = \sqrt{\text{radius}^2 + \tan^2}$$

$$\text{Cosec} = \frac{1}{\sin}; \quad \text{Versin} = \text{radius} - \text{Cos}$$

$$\text{Coversin} = \text{radius} - \text{Sin}$$

$$\text{Radius} = \tan \times \cot = \sqrt{\sin^2 + \cos^2}$$

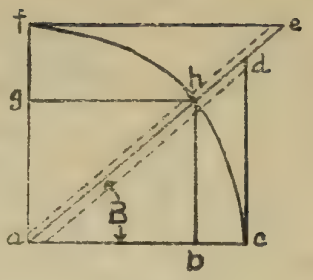


Fig. 19

When R = 1
Sin B = bh
Cos B = gh
Tan B = cd
Cot B = ef
Sec B = ad
Cosec B = ae
Vers B = bc
Covers B = gf

Right triangles, Fig. 20:—

C = right angle = 90°; c = hypotenuse

$c^2 = a^2 + b^2$; $b^2 = (c^2 + a^2)\ (c^2 - a^2)$

$a^2 = (c + b)\ (c - b)$

$$\text{Sin B} = \frac{b}{c}; \quad \text{Cos B} = \frac{a}{c}; \quad \text{Tan B} = \frac{b}{a};$$

$$\text{Cot B} = \frac{a}{b}; \quad \text{Sec B} = \frac{c}{a}; \quad \text{Cosec B} = \frac{c}{b}$$

$a = b \tan A$; $a = c \text{ Sin A}$; $b = c \text{ Cos A} = a \text{ Cot A}$;

$b = \sqrt{(c + a)\ (c - a)}$; $c = \sqrt{a^2 + b^2} =$

$$\frac{a}{\text{Sin A}} = \frac{b}{\text{Cos A}}$$

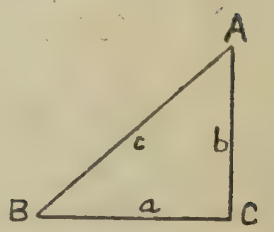


Fig. 20

Frustrums:—

Cone. Refer to Fig. 21.

Area of convex surface (not including ends) = ½ sum of perimeters of bases × slant height (S) of frustrum.

Volume = 1/3 Π h $(R^2 + r^2 + Rr)$.

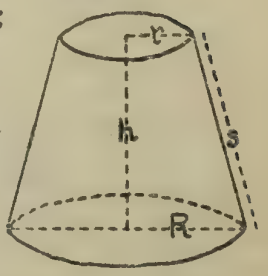


Fig. 21

Pyramid. Refer to Fig. 22.

Area same as for cone.

Volume = 1/3 h $(B + \sqrt{Bb} + b)$.

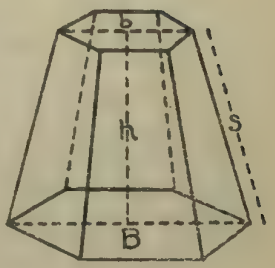


Fig. 22

Wedge. Refer to Fig. 23.

Volume = Area of base (B) × ½ altitude (h).

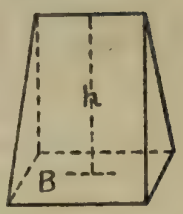


Fig. 23

Any irregular plane surface. Refer to Fig. 24.

Area obtained as follows:—
Divide surface into n parallel strips of equal widths, d, whose middle ordnates are h_1, h_2, h_3, ----- h_{n-1}, h_n.

Approx. area $= d\,\Sigma h + 1/12\,d\,(a - h_1) + 1/12\,d\,(b - h_n)$,

More exact area $= d\,\Sigma h + 1/72\,d\,(8a + h_2 - 9h_1) + 1/72\,d\,(8b + h_{n-1} - 9h_n)$.

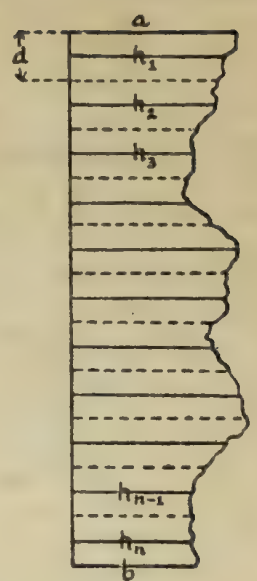


Fig. 24

To construct right angle at Y:—

Y as center; r, convenient radius. Cut line at A and B. A as center, r′ as radius = to about 1½ AY, draw arc above Y. Do same with B as center, using same radius r′. Intersection of arcs = X. Draw the perpendicular YX. Fig. 25.

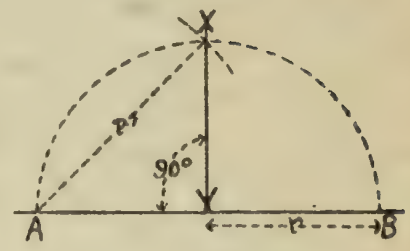


Fig. 25

Also:—

Assume B with radius = r = BY and from B as center draw arc XYZ greater than semicircle, and to cut AY, as at Z. Draw ZB, and prolong it to cut upper portion of this arc, as at X. Draw the perpendicular YX. Fig. 26.

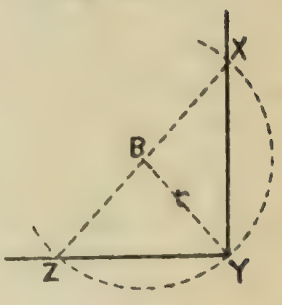


Fig. 26

Also:—

Make ZY proportional to 4 with Z as center, draw arc, radius proportional to 5, with Y as center, radius proportional to 3, draw arc. X = point of intersection of arcs. Draw the perpendicular YX. Fig. 27.

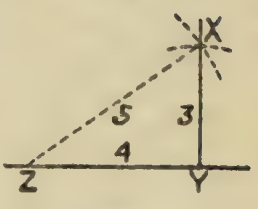


Fig. 27

To construct a perpendicular to a line:—

AB = the line; X is point outside. With X as center and with radius r greater than XY draw arc ZV, cutting line AB at Z and B. Bisect ZV; Y = point of bisection. Draw perpendicular YX. Fig. 28.

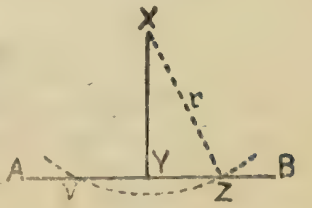


Fig. 28

To bisect an angle:—

L = AYB. With Y as center, any convenient radius, draw arc VZ. V as center, any convenient radius, r, draw arc. Same at Z, using same radius. X = point of intersection of arcs. Draw bisecting line YX. Fig. 29.

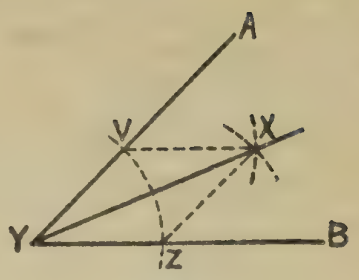


Fig. 29

To construct equilateral triangle:—

Line = AB. With Y as center, any radius, as YZ, draw arc XZ. Same radius, Z as center, draw arc intersecting other one at X. XZY = equilateral triangle. Fig. 30.

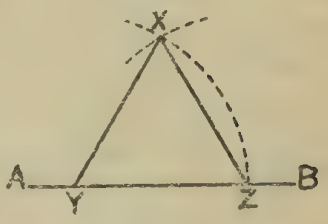


Fig. 30

To construct angle equal to an angle:—

ABC = given angle. With B as center, any radius, draw arc YX. Draw any line A′Z′. With Z′ as center, radius Z′Y′ = BY draw arc Y′X′. With Y′ as center, radius = cord YX draw arc intersecting other one, at X′. Draw X′Z′. Angle A′Z′X′ = angle ABC. Fig. 31.

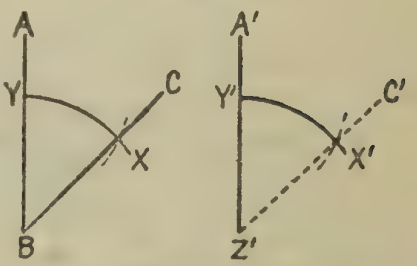


Fig. 31

To construct a line parallel to a line:—

AB = the line. Construct perpendiculars to AB, as YY′, XX′. Make YY′ = XX′. Draw the parallel line Y′X′. Fig. 32.

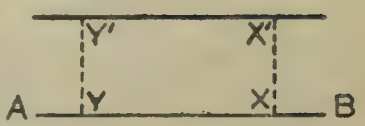


Fig. 32

To divide a line into given number of parts:—

Refer to figure.

Let AB be the line, say 5 27/60 units long, to be divided into, say 6 parts. Select a length, AC, divisible by 6, as 6 units. Lay off AC. Divide AC into 6 parts, join CB; draw parallel lines as shown. Caution: make angle abc as nearly a right angle as possible, by positioning point C. Fig. 33.

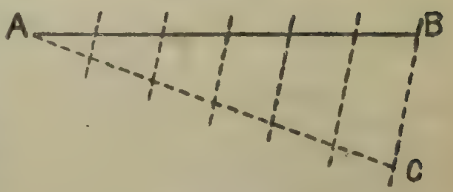


Fig. 33

To draw a circle through 3 points:—

Join points by two lines, as ab, bc, and construct a bisecting perpendicular on each. Where these intersect will be center of circle, d. Fig. 34.

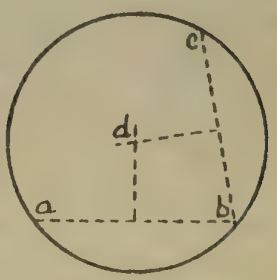


Fig. 34

To find the distance across a river on the line DAB:—

Measure AC along the bank and take the angles BAC and ACB. Then we have one side and two angles to find AB. If we can make ACB = ½ DAC, then AB = AC. Fig. 35.

Fig. 35

Again: (Fig. 36)

Lay off AC perpendicular to AB, measure AC and lay off CD perpendicular to CB. Then $AB = \frac{(AC)^2}{AD}$; or make ACE = ACB, then AB = AE.

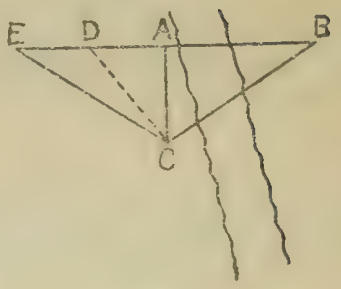


Fig. 36

Again: (Fig 37)

Measure AD in an oblique direction from bank and fix C at middle point. From E measure EC and make CF = EC, making DF parallel to FB. Then find point G in line of CB and DF. Then GD = AB.

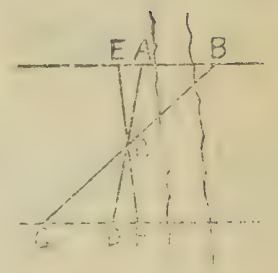


Fig. 37

To find distance AB from B:—

Lay out BE at right angles to AB. Produce BE to C, so that EC may be some even fraction, as one-eighth or one-tenth of BE. From C lay out as before CD perpendicular to BC, so that D, E, and A may all be in one continued line. Measure CD, then EC : CD :: BE : AB. Fig. 38.

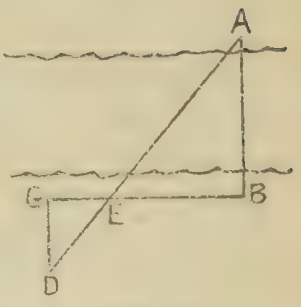


Fig. 38

To measure the inaccessible distance AB:—

Plant a staff at C from where both A and B can be seen. By the preceding rules find CA and CB, make CD as many parts of CA as CE is of CB. Join DE, then CD : DE :: CA : AB. Fig. 39.

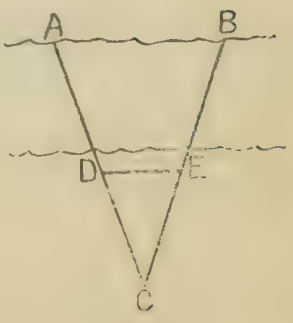


Fig. 39

To let fall a perpendicular upon the line AB from an inaccessible point D:—

From A and B lay out AD and BD. Let fall the perpendicular AH and BF upon the sides AD and BD. Mark their intersection c, and the prolongation of D c will give the point where the perpendicular cuts the line AB as required. Fig. 40.

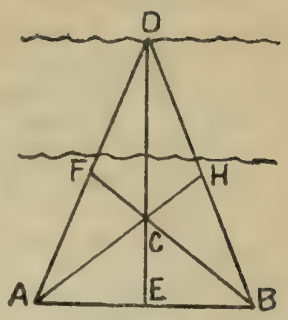


Fig. 40.

FRACTIONS

Addition:—Multiply the top and the bottom figures of each fraction by a number that will make the bottom figure the same, then add the top figures. Example:—2/3+¾ = 8/12+9/12 = 17/12 = 1 5/12; also 2½+3⅞ = 2+3+½+⅞ = 5+½+⅞ = 5+4/8+7/8 = 5+11/8 = 5+1⅜ = 6⅜.

Subtraction:—As for addition, but subtract. Example:—2/3—3/5 = 10/15—9/15 = 1/15; also 3⅛—2¾ = 2 9/8—2¾ = 2—2 9/8—¾ = 9/8—6/8 = ⅜.

Multiplication:—Multiply the two top figures together and the bottom ones together. Example:—2/3×4/5 =8/15; also 5 2/3×2¾ = 17/3×11/4 = 178/12 = 15 7/12.

Division:—Reverse the divisor and multiply. Example:—2/3 ÷ 4/5 = 2/3×5/4 = 10/12; also 5 2/3÷2¾ = 17/3÷11/4 = 17/3×4/11 = 68/33 = 2 5/33.

DECIMALS

Addition and Subtraction:—Get the decimal points one directly under the other, then handle as for any number. Example:—32.01+4.2 = 36.21; also 32.01—4.2 = 27.81.

Multiplication:—Handle as for any numbers but in result point off number of places equal to sum of places in the two decimal quantities. Example:—32.01×4.2 = 134.442.

Division:—Make the **divisor** a whole number by moving its decimal point to the extreme right. Move the decimal point in the other quantity the same number of places to the right (adding 0's if necessary); draw the division line over such quantity and place a decimal point **directly** over the point just established, then divide as for whole numbers. Example:—4.2034÷52.01 = 420.34÷5201 = .0808 etc.

5201) 420.34

ARITHMETICAL AND GEOMETRICAL SERIES

Arithmetical:—Last term—number of terms less 1 × common difference, then add first term. **Sum of all terms**—sum of extremes × ½ number of terms.

Geometrical:—Last term—1st term times the ratio of the series raised to a power equal to the number of terms less 1. If decreasing, divide instead of multiplying. **Sum of all terms:**—1st term × the ratio of the series raised to a power equal to the number of terms; subtract the 1st term; divide by the ratio diminished by unity.

Square Root:—

Point off in periods of two figures from decimal. Find the greatest square in first period and place its root in the quotient. Subtract the square from first period and bring down the next period. Double the root already found and place this at the left of the dividend for a trial divisor. Find how often this is contained in the dividend, exclusive of the right hand figure, and place the quotient in the result as the second figure of the root. Annex the last figure of the root to the trial divisor for the complete divisor. Multiply the complete divisor by the last figure of the root, write this under the dividend, subtract, bring down the next period if any, and continue as before.

Cube Root:—

Begin at the right hand and point off in periods of three places each. Find the greatest cube in the left hand period and place its root in the quotient. Subtract the cube from the left hand period and bring down the next period. Square the root found and multiply it by 300 for a

trial divisor. Find how often this is contained in the dividend and place the quotient in the result as the next figure of the root. Multiply the last figure of the root by the root and by 30, and write the result under the trial divisor. Square the last figure of the root and place the result under the trial divisor. Add together the trial divisor and the two quantities beneath it and this will be the complete divisor, which multiply by the last figure of the root, write the product under the dividend, subtract, bring down the next period, if any, and continue as before.

TABLES OF WEIGHTS AND MEASURES

LINEAL

Inches	Feet	Yards	Fathoms	Perch or Rod	Furlong	Mile
12	1					
36	3	1				
72	6	2	1			
198	16.5	5.5	2.75	1		
7,920	660	220	110	40	1	
63,360	5,280	1,760	880	320	8	1

Chain:—Surveyor's Chain (or Gunter's) is 66 ft. long, composed of 100 links, each 7.92 inches in length; 80 chains = 1 mile; 10 sq. chains = 1 acre. Engineer's Chain is 50 or 100 ft. long, composed of links each 12 inches in length. The handles of chains form part of the end links.

NAUTICAL

1 Nautical mile = 6,086 ft; 3 N. miles = 1 league; 60 N. miles = 20 leagues = 1 degree = 69.16 English miles.

SQUARE

Inches	Feet	Yards	Perch	Roods	Acres
144	1				
1,296	9	1			
39,204	272.75	30.25	1		
1,568,160	10,890	1,210	40	1	
6,272,640	43,560	4,840	160	4	1

LAND

1 Acre = 69.5701 yds. sq., or 208.710321 ft. sq.
1 Township = 6 miles square = 36 sections.
1 Section = 1 mile square = 640 acres.
¼ Section = ½ mile square = 160 acres.
1/16 Section = ¼ mile square = 40 acres.

CUBIC

1,728 cu. in. = 1 cu. ft.
46,656 cu. in. = 27 cu. ft. = 1 cu. yard.

DRY

Pints	Quarts	Gallons	Pecks	Bushels	Cu. Inches
1					33.6
2	1				67.2
8	4	1			268.8
16	8	2	1		537.6
64	32	8	4	1	2,150.4

The standard U. S. bushel contains 2,150.42 cu. inches, the British, 2,218.192.

1 British quarter = 8 Imperial bushels = 8¼ (approx.) U. S. bushels = 10.2694 cubic feet.

TROY

Grains	Dwt.	Ounces	Pounds
24	1		
480	20	1	
5,760	240	12	1

1 Troy pound = 22.816 cu. inches distilled water at 62°F.

AVOIRDUPOIS WEIGHT

Drachms	Ounces	Pounds	Quarter	Cwt.	Tons
16	1				
256	16	1			
6,400	400	25	1		
25,600	1,600	100	4	1	
512,000	32,000	2,000	80	20	1

1 Ounce Avoir.—437.5 Grains Troy. 1 Pound Avoir.—1.2153 Pounds Troy.

APOTHECARIES' WEIGHT

Grains	Scruples	Drachms	Ounces	Pounds
20	1			
60	3	1		
480	24	8	1	
5,760	288	96	12	1

Written:—Scruple ; Drachm ; Ounce .

APOTHECARIES' MEASURE

60 minims—1 fluid drachm; 8 fluid drachms—1 fluid ounce; 16 fluid ounces—1 pint; 8 pints—1 gallon.

Following values are approximate: 45 drops—1 teaspoonful—1 fluid drachm; 2 teaspoonfuls—1 dessertspoonful—2 fluid drachms; 2 dessertspoonfuls—1 tablespoonful—4 fluid drachms; 2 tablespoonfuls—1 fluid ounce; 3 tablespoonfuls—1 wineglassful—1½ fluid ounces; 8 tablespoonfuls—1 teacupful—4 fluid ounces. 1 teaspoonful—4 cubic centimeters.

(For Army Dispensary Use)

Grains	Milligrams (nearly)	Grams or Cc's Written
1/60	1	.001
1/20	3	.003
1/16	4	.004
1/6	10.8	.011
1/4	16	.016
1	65	.065
3	194	.20
5	324	.32
8	518	.52
16 (use 15)	1040	1.
20	1296	1.3
30	1944	1.9
60	3887	3.9

Note:—G. is the abbreviation for grams; Gr. the abbreviation for grains; Cc. for cubic centimeters. In a 60 Cc. mixture the number of grams or Cc's required of each ingredient is equal to the number of grains or minims given as the dose of each ingredient.

Fluid Drachm	Cubic Centimeters	
1	3.70	3.7
2	7.39	7.4
3	11.09	11.
4	14.78	15.
8	29.57	30.

60 Cc's equal 15 teaspoonfuls, or 15 doses in a 4-ounce bottle.

Fluid Ounces	Cubic Centimeters	
2	59.14	59
4	118.29	118
6	177.44	177
8	236.59	237
16	473.11	473
32	946.35	946

LIQUID

Gills	Pints	Quarts	Gallons	Hogsheads	Pipe	Tun	Cu. Inches
1							7.2187
4	1						28.875
8	2	1					57.75
32	8	4	1				
2016	504	252	63	1			
4032	1008	504	126	2	1		
8064	2016	1008	252	4	2	1	

THE GALLON

A standard U. S. Gallon—231 cubic inches, and holds 8.339 pounds Avoir. of distilled water at its maximum density weighed in air, barometer being at 30 inches. An Imperial English Gallon—277.274 cu. inches. 1 Imperial Gallon—1.20032 U. S. Gallons.

SIZES OF MEASURES

The following measures hold the assigned quantities very nearly; the first dimension is the diameter, the second the height, both in inches:—Gill, 1¾, 3; Pint, 3½, 3; Quart, 3½, 6; 1 Gallon, 7, 6; 8 Gallons, 14, 12; 10 Gallons, 14, 15.

METRIC WEIGHTS AND MEASURES

DRY AND LIQUID

	Liters	Cubic Inches	Liquid	Dry
1 milliliter	0.001	0.061	0.00845 gill	0.0018 pints
1 centiliter	0.01	0.61	0.0845 gill	0.018 pints
1 deciliter	0.1	6.1	0.845 gill	0.18 pints
1 liter	1.	61.02	2.113 pints	1.8 pints
1 decaliter	10.	610.16	2.641 gallons	9.08 quarts
1 hectoliter	100.	3.531 cu. ft.	26.41 gallons	2.837 bushels
1 kiloliter	1000.	35.31 cu. ft.	264.141 gallons	28.374 bushels
1 myrialiter	10000.	353.1 cu. ft.	2641.41 gallons	283.74 bushels

LINEAL

	Meters	Inches	Feet	Yards	Miles
1 millimeter	0.001	0.03937	0.00328		
1 centimeter	0.01	0.3937	0.0328		
1 decimeter	0.1	3.937	0.32807	0.10936	
1 meter	1.	39.3685	3.2807	1.0936	
1 decameter	10.		32.807	10.936	
1 hectometer	100.		328.07	109.36	0.0621347
1 kilometer	1000.		3280.7	1093.6	0.621347
1 myriameter	10000.		32807.	10936.	6.21347

Note:—1 millimeter is nearly 1/25 of an inch; 1 centimeter is a full ⅜ of an inch.

SQUARE

	Sq. Meters	Sq. Inches	Sq. Feet	Sq. Yards	Acres
1 sq. centimeter	0.01	0.155			
1 sq. decimeter	0.1	15.5	0.10763	0.1196	
1 centare	1.	1549.88	10.763	1.196	0.00025
1 are	10.	154988.	1076.3	119.6	0.0247
1 hectare	100.		107630.	11959.	2.47
1 sq. kilometer	0.38607 sq. miles				247.0
1 sq. myriameter	38.607 sq. miles				24708.

CUBIC

	Cubic Meters	Cubic Inches	Cubic Feet	Cubic Yards
1 cu. centimeter	0.0001	0.0610165		
1 cu. decimeter	0.001	61.0165		
1 cenistere	0.01	610.165	0.353105	
1 decistere	0.1	6101.65	3.53105	0.13078
1 stere	1.		35.3105	1.3078
1 decastere	10.		353.105	13.078
1 hectostere	100.		3531.05	130.78

WEIGHT

	Grammes	Troy Grains	Avoir. Ounces	Avoir. Pounds
1 milligramme	0.001	0.01543		
1 centigramme	0.01	0.1543		
1 decigramme	0.1	1.5433		
1 gramme	1.	15.43316	0.03528	0.0022047
1 decagramme	10.		0.3528	0.022047

Grammes	Troy Grains	Avoir. Ounces	Avoir. Pounds
1 hectogramme	100.	3.52758	0.2204737
1 kilogramme	1000.	35.2758	2.204737
1 myriagramme	10000.		22.04737
1 quintal	100000.		220.4737
1 tonneau .....1000000.			2204.737

HANDY REDUCING MULTIPLIERS

INCHES:—**Square Inches** × 0.00695 = sq. ft. **Cubic Inches** × 0.00058 = cu ft; × 0.003607 = Imperial gallons; × 0.000466 = U. S. bushels; × 0.004329 = U. S. gallons. **Cylindrical Inches** × 0.0004546 = cu. ft.; × 0.002832 = Imperial gallons; × 0.0034 = U. S. gallons; × 0.02842 = lbs. avoir. (water); 2200 cylindrical inches = 1 cu. ft. **Circular Inches** × 0.00546 = sq. ft. 183.346 circular inches = 1 sq. ft.

FEET:—**Lineal Feet** × 0.00019 = English statute miles; × 1.515 = links. **Square Feet** × 0.111 = square yards.

Cubic Feet × 0.6238 = Imperial gallons; × 0.03704 = cubic yards; × 0.8036 = U. S. bushels; × 0.779 = British bushels; × 7.48 = U. S. gallons; × 2.375 = barrels.

Cylindrical Feet × 0.02909 = cubic yards; × 4.895 = Imperial gallons; × 5.878 = U. S. gallons; × 49.1 = lbs. avoir. (water); × 0.63111 = U. S. bushels; × 0.61183 = British bushels.

YARDS:—**Lineal Yards** × 0.000568 = English statute miles; × 0.0006 = miles; × 4.545 = links. **Square Yards** × 0.0002066 = acres.

LINKS:—Links × 0.22 = yards; × 0.66 = feet.

CHAINS:—Chains × 0.0125 = miles; width in chains × 8.0 = acres per mile.

ACRES:—Acres × 4840.0 = sq. yds.; × 43560.0 = sq. ft.

MILES:—Miles × 5280.0 = ft; × 1760.0 = yards; × 80.0 = chains.

POUNDS AVOIR.:—Avoirdupois pounds × 0.009 = cwt.; × 0.00045 = tons (large).

U. S. BUSHELS:—U. S. bushels × 0.0459 = cubic yards; × 1.2446 = cu. ft.; × 2150.42 = cu. inches.

U. S. GALLONS:—U. S. gallons × 0.13368 = cubic feet; × 231.0 = cubic inches; × 8.33 = lbs. avoir. (water); × 0.83 = Imperial gallons; × 3.8 = liters.

IMPERIAL GALLONS:—Imperial gallons × 277.274 = cu. inches; × 0.16 = cu. feet; × 10 = lbs. avoir. (water); × 1.2 = U. S. gallons; × 4.537 = liters.

POUNDS PER CUBIC FOOT

METALS:—Aluminum 166; brass 524; bronze 534; copper, cast 540; rolled 548; copper wire 555; iron, cast 450, wrought 485, average 480; lead cast 708, rolled 711; steel, soft 487, hard 490; tin, cast 455; mercury 849; zinc 437.

WOOD, Seasoned:—Apple 49; ash 47; beech. 43; birch 45; box 60; cedar, West Indian 47, American 35; cherry 42; chestnut 41; cork 15; ebony 74; elm 35; hemlock 25; hickory 53; hornbeam 47; ironwood 71; larch 35; lignum vitae 83; mahogany, Spanish 53, Honduras 35; maple, rock 49, soft 42; oak, live 60, white 52, red 45; pine, white 25, yellow northern 35, yellow southern 45; sycamore 37; teak 46; walnut 35. Note:—Green timber weighs about 1/3 more than seasoned.

ROCK, BRICK, MORTAR, etc.:—Asphaltum 87; basalt 181; brick, common 100 to 125, pressed 134, fire 150; brickwork in mortar 110, in cement 112; cement, Portland loose 78, Rosendale loose 60; chalk, solid 145; charcoal, average 20; clay 119; coal, anthracite, solid 94, broken 54; coal, bituminous, solid 84, broken 49; coal, cannel, solid 79, broken 42; coke 26; concrete, in cement 137, ordinary 119; earth, very compact 125, ordinary 77; glass, flint 192, window 157, plate 172; flooring 168; granite 164; gutta percha 60; gypsum 143; gneiss 168; limestone 168, loose 96; lime, quick 53, shaken 75; marble 168; masonry, ashlar 160; ruble 180; mortar, average 106; pitch 72; porphyry 170; pumice stone 57; quartz 165; sand, river 117, coarse 100; sandstone 150; shale 162; slate 175; trap 170; tile 115.

MISCELLANEOUS:—Snow, fresh 5 to 12, wet 15 to 50; sulphur 125; tallow 59; tar 63; gunpowder, coarse 57, fine 56; atmospheric air at

sea-level at 60° F., 0.0765; ice 58.7; water, distilled 62.35; water, sea 63.84; petroleum 55; mud 80 to 120; salt, coarse 45, fine 49; hay, loose 3.2, baled 11.

POUNDS PER BUSHEL

Wheat 60; corn, shelled 56, on cob 70; rye 56; barley 48; oats, average 33; cornmeal 50; bran 20; beans 60; onions 55; salt, average 56; turnips 55; potatoes, Irish 60; potatoes, sweet 55; apples, green 56, dried 24; peaches, dried 33; peas 64; coal, bituminous 76, anthracite 86; coke 40; charcoal 30. **Seed**:—clover 60; flax 56; timothy 45; millet 50; bluegrass 14; red top 14; Hungarian grass 50. **Cement**:—Rosendale 70; Louisville 62; Portland 96; lime, loose 70, well shaken 80; **sand, average** 122.5.

POUNDS PER BARREL

Flour 196; salt 280; beef 200; pork 200; fish 200.

POUNDS PER GALLON

Water, distilled 8.38; water, sea 8.55; acid, acetic 8.78; acid, nitric 10.16; acid, sulphuric 15.48; acid, muriatic 9.93; alcohol, pure 6.7, proof 7.62, commercial 6.93; milk 8.55; molasses 11.66; oil, linseed 7.85; oil, olive 7.62; oil, turpentine 7.16; oil, sperm 7.65; naptha 7; petroleum 7.39; tar 8.3.

WEIGHTS OF METALS

To estimate weight of metals:—Multiply the number of cubic inches in the metal object by the following: cast iron, 0.263; wrought iron or steel, 0.282; copper, 0.3225; brass, 0.3037; zinc, 0.26; lead, 0.4103; tin, 0.2636; mercury, 0.49.

Iron Plates:—Lbs. = square inches of surface × thickness in inches × 0.28. **Round iron bars**:—Lbs. = square of diameter in inches × length in feet × 2.6. **Flat iron bars**:—Lbs. = area of end in inches × length in feet × 3.32.

Weight of wire:—100 lineal feet of No. 0 B. W. G., weight in lbs:—iron, 30.58; steel, 30.92; brass, 33.43; copper, 35.17; and the weight of other sizes in direct ratio to their cross sectional area compared to No. 0.

Max. Tensile Strength:—Round iron bars:—Express diameter in quarters of an inch, square this value, result is tensile strength in tons. Example:—bar ¾″ diameter = 3^2 = 9 tons. **Square iron bars**:—Find as for round and allow ¼ inch more. **Steel bars**:—3 times that of iron.

THE TON

Ships:—1 register ton = 100 cubic feet; the **gross tonnage** of a ship is her total internal space capacity which is completely closed in and protected from weather, measured in **register tons**; the net **register tonnage** total internal capacity available for passengers and cargo, usually 60% of gross tonnage; **displacement tonnage** is weight of ship complete with cargo and contents, measured in tons of 2240 lbs. each, or, in countries using metric system, in 1000 kilograms (2204.6 lbs.); **Freight tonnage**, 40 cubic feet of cargo is one **Shipping ton**, unless that bulk exceeds 2240 (or often 2000) pounds, when the freight charge is made by weight. To get transport capacity of a ship:—Small ships, allow 4.5 gross tons per man and 11 gross tons per animal; for ships over 5000 tons, allow 3.5 gross tons per man and 9 gross tons per animal (includes rations, water, vehicles, etc.). 1 U. S. shipping ton = 40 cu. ft. = 31.16 Imperial bushels = 32.143 U. S. bushels. 1 British shipping ton = 42 cu. ft. = 32.719 Imperial bushels = 33.75 U. S. bushels.

Long and short ton:—One long ton = 2240 lbs.; 1 short ton (or merely ton) = 2000 lbs.; 1000 kilograms nearly = 1 long ton, being 2204.6 lbs. Tons × 20 = cwt.

Number of cubic feet to a ton:—Oats 65; barley 52; corn 45; bran 120; hay, baled, over-sea shipment, 82; coal, long ton 35, short ton 31¼; hay, stacked, and settled, 400, newly stacked 500.

CONSTRUCTION SUPPLIES

Brickwork:—Brickwork measured by 1,000 bricks laid in the wall, no standard size, usually 8¼″ by 4″ by 2¼″. Pressed brick weighs 150 lbs., hard brick about 125 lbs., and soft brick about 100 lbs. per cubic foot.

Common bricks average 4½ lbs. each. To find number of bricks required for any number of cubic feet of brick construction multiply the number of cubic feet by 22½. Height of brick pillar should not exceed 12 times least thickness at base. Corners are not measured twice as in stone work. Openings over 2 feet square are deducted. Arches are counted from the spring. Pillars are measured on their face only. A cubic yard of mortar requires 1 cubic yard of sand and 9 bushels of lime, and will fill 30 hods. One thousand bricks, closely stacked, occupy about 56 cubic feet. One thousand old bricks, cleaned and loosely stacked, occupy about 72 cubic feet. One superficial foot of gauged arches requires 10 bricks. Paving-bricks should measure 9″ by 4½″ by 1¾″, and weigh about 4½ lbs. each. One yard of paving requires 36 stock bricks, of above dimensions, laid flat, or 52 on edge; and 35 paving bricks laid flat, or 82 on edge. Laid flat allow 4½ brick per square foot of wall.

Stonework:—Stone walls are measured by the perch. 1 perch = 16½′ x 1½′ x 1′ = 24¾ cu. ft. Openings less than 3 feet wide are counted solid; over 3 feet deducted, but 18 inches are added to the running measure for each jamb built. Arches are counted solid from their spring. Corners of buildings are measured twice. Pillars less than 3 feet are counted on 3 sides as lineal, multiplied by fourth side and depth.

Measure all foundation and dimension stone by the cubic foot. Water tables and base courses by lineal feet. All sills and lintels or ashlar by superficial feet, and no wall less than 18 inches thick. Maximum safe load per superficial foot in tons:—granite piers 40; limestone piers 25; sandstone piers 15; brickwork in cement 3; rubble masonry 2; lime concrete foundations 2½. Height of stone pillar should not exceed 12 times least thickness at base.

Number of perch in a wall = cubic feet × 0.0404.

Concrete:—Concrete walls are built of 1 part of cement to 6 or 7 of broken stone, shingle, gravel, or slag. The substance mixed with the cement must be free from loam, fine sand, clay, or dirt of any kind.

To prevent the cement from adhering to the planks of the mould, apply freely to them with a brush soap boiled to the consistency of paint. Data regarding mixtures for 2½″ stone and under, for 1 cubic yard of concrete, proportions:—Cement 1, sand 1, stone 3, use 2.25 barrels cement, 0.32 cu. yds. of sand, 0.9 cu. yds. stone; cement 1, sand 2, stone 4, use 1.57 barrels of cement, 0.45 cu. yds. sand, 0.9 cu. yds. of stone; cement 1, sand 3, stone 5, use 1.22 barrels cement, 0.52 cu. yds sand, 0.87 cu. yds. of stone; cement 1, sand 3, stone 7, use 1 barrel cement, 0.42 cu. yds. sand, 0.98 cu. yds. stone.

Boards:—Area of a lineal foot multiplied by length in feet will give superficial contents in square feet.

Timber is measured in board feet (BM) which is the number of superficial feet the piece would contain if sawed into boards 1″ thick and 12″ wide. Thicknesses less than 1″ are counted as an inch or sold by the square foot. 1 cubic foot (of board) is 12 feet board measure.

Ceiling, sizes are ⅜″ to ¾″ thick; 4″ to 6″ wide, including tongue; matched and dressed on both sides. **Flooring,** sizes are 1″ to 1¼″ thick, 4″ to 6″ wide including tongue. **Stepping** embraces all sizes 1″ to 2″ thick and from 7″ up in width. **Plank** embraces all sizes from 1½″ to 5″ thick and from 7″ up in width. **Dimension timber,** all sizes from 6″ up in thickness and 7″ up in width.

Shingles:—Best are of white cedar. Shingles are packed 250 to the bundle, or 4 bundles to 1,000. 1 bundle 16-inch shingles will cover 30 square feet. 1 bundle 18-inch shingles will cover 33 square feet. When laid 5½″ to the weather, 5 lbs. 4d or 3¼ lbs. 3d nails will lay 1,000 shingles.

Clap-boards:—1 bundle laid 3½ inches to weather will cover 26 square feet.

To find weight of timber work:—Flooring:—Multiply breadth in feet by length in feet by thickness in inches and by one of the following factors according to material:—For elm use 3.5 lbs.; for yellow pine, 3.42; for white pine, 2.97; for dry oak, 4.04. **Beams post:**—Multiply length in feet by breadth and depth in inches, and the product by one of the following factors:—For elm, 2.92; yellow pine, 2.85; white pine, 2.47; dry oak, 4.04.

To find length of rafters:—Pitch 1 on 3, multiply width of building by 0.6; pitch 1 on 2, multiply by 0.7. Does not include projection beyond edge of building.

Whitewash—For outside woodwork:—In a tight bushel, slack ½ a bushel of fresh lime by pouring over it boiling water sufficient to cover it 4 or 5 inches deep, stir until slacked; add 2 lbs. of sulphate of zinc dissolved in water, add water enough to bring all to the consistency of thick whitewash. **For inside work**:—Add 2 quarts of thin size to a pail full of wash just before using. The common practice of mixing salt with whitewash should not be permitted. **For brick or stone-work**:—Slack ½ bushel of lime, as before, in a barrel; then fill the barrel 2/3 full of water and add a bushel of hydraulic cement; add 3 lbs. sulphate of zinc dissolved in water. These washes may be colored by adding powdered ochre, umber, etc.

Paint for Iron:—Iron exposed to weather, use yellow or red iron ochres. Iron exposed to action of water, use red lead.

Putty, Painters':—Pulverized Spanish whiting 80.6% and boiled oil 20.4%. To keep, submerge in raw linseed oil. One pound putty per 20 square yards. **Glaziers'**:—Whiting 70%, boiled oil 30%, water to mix. If too thin, add whiting; too thick, add oil. To soften old putty:—paint old putty with caustic soda (concentrated lye) and leave it for an hour to soften.

Slates:—Slate weighs about 175 lbs. per cu. ft. Number of slates to 100 sq. ft. is given by:—Multiply half the width of the slate by its length less 3 inches (dimensions in inches) and divide 14,400 by the result.

Tin:—One box of 225 sheets 13¾″ x 10″ will cover 150 sq. ft.

Corrugated Iron Roofing:—Galvanized iron weighs from 5 to 15% heavier than plain of same gauge.

Weight:—1st figure is number B. W. gauge and 2nd figure is weight in lbs. per 100 sq. ft. (called a "square"): 28, 97; 26, 105; 24, 128; 22, 150; 20, 185; 18, 270; 16, 340; for durable roof use not lighter than No. 22. Usually made in sheets 6′ to 8′ long and 2′ to 3′ wide; for roofing, allow 6″ over-lap on all edges; or allow 1/3 of net width for lappage; allow 2½ to 3½ pounds rivets per "square."

Rubberoid Roofing:—One roll covers 100 square feet, allowing for lappage.

EXPLOSIVES

Those for **military** purposes:—Gun cotton, nitroglycerine, Dynamite, Picric acid and Picrates; Fulminates; Sprengel safety mixtures, gunpowder and smokeless powders. Jovite (picric compound), good for military purposes, may be had equal to 20, 40, and 60% dynamite.

No. 1 dynamite = 75% nitroglycerine; No. 2 = 50%; No. 3 = 25%.

Dynamite higher than 60% not suited for military purposes. Keep cartridges on side, not on end.

Dynamite freezes at 40°F. and is safe to handle, but easily exploded by heat, thawed carefully, and at low heat, placed on side when thawing, best way, pack in fresh manure or place in closed place with cans of hot water.

Sprengel Mixtures:—Keep copper case of cap from contact with acid, use paraffine on case.

Fuses:—Time fuse, about 3 feet per minute. Instantaneous, 120 feet per second.

Caps:—Single strength, 3 grains; double, 6 grains; triple, 9 grains fulminate. Simultaneous explosion by electricity; connect fuses in **series.**

Rules:—Gun cotton, keep saturated with 30% its weight of water. Cotton for primers kept dry, dip cakes in melted paraffine. Dry wet cakes at temperature not exceeding 120°F. Keep all other powders in a dry, cool, shaded, and well ventilated place.

By "1 STICK" is meant a cylindrical cartridge of dynamite 1¼″ x 8″, weighing about 0.6 lbs. per running foot.

Calculations based on explosives equal in strength to 50% dynamite. For gunpowder, double the charge and tamp well.

Stick = cylindrical cartridge 1¼″ x 8″, weight 0.6 lbs.; chain = 1 lb. per running foot, sticks end to end.

Values:—C = charge in pounds, 50 % dynamite; d = diameter in feet; B = breadth in feet of section to be demolished; T = thickness in feet; t = thickness in inches.

Timber:—½ lb. per square foot of sectional area, in holes bored in same horizontal plane. Tamped with clay.

Round Timber:—Not over 12 inches diameter, may use chain, fitting snugly.

Piles under water:—Cut with chain, snug fitting not essential.

Square timbers:—Bore parallel holes in direction of the dimension which is nearest to 12 inches for whole sticks, or nearest 8 inches for half sticks.

Bridge timbers:—4 pounds per sectional square foot, and chain may be used.

Masonry walls:—Charge per running foot is given by $C = 0.85\ T^2$. Laid in chains at foot of wall and tamped. If tamping equal thickness of wall, reduce charge 1/3; if, besides tamping, a groove is cut, reduce charge ½.

Houses:—In haste, 50 lbs. in center of house; or as for walls, charge placed on inside of house.

Bridge abutments:—At back, low down, sink trench, tamp charge.

Masonry bridges:—Charge ½ greater than for wall of same thickness. Charge not less than T^2 lbs. per running foot, T reckoned from surface of roadbed to soffit of arch. Charge may be placed in trough and suspended under crown. 12 inch planks make trough that will hold 36 lbs. per running foot. Place primers 3 or 4 feet apart.

Metals:—girders, plates, etc.

Standard formula, $C = 2.5\ Bt^2$. Charge must be laid entirely across plate or sheet.

A single chain will cut a plate up to ⅝ inches thick; 2 chains, ⅞ inches thick; 3 chains, 1⅛; 4 chains, 1¼.

For structural shapes, figure width as sum of web and flange widths, and thickness as area of cross section in square inches. Charge in three parts, one on web, one on each flange. For lattice girders, diagonals and posts, all longitudinal members must be cut; for plate girders, web and flanges are cut.

Guns:—3 to 6 lbs. in bore, tamped.

R. R.'s:—At frogs and switches, 1 stick to 70 lb. rail.

Land Mines:—About 25 lbs. dynamite.

Where to place charge:—

Trees, in holes bored in same plane, or as necklace. Masonry, in trench, low down, or under part of wall, tamped well. Houses, inside house, between windows. Wooden trusses, near middle of lower cord. Steel trusses and girders, cut all members on same cross-section; cut near the abutments. Cantilever bridge, cut over the towers, completely rupturing top cords.

Wire cables of suspension bridges:—Charge $C = 0.16\ t^3$; place charge between cable and top of tower, near the saddle.

Rock blasting:—Let h = length of charge, d = depth of hole, L = length of line of least resistance, v = depth of tamping.

In stratified rock, medium hardness, depth of hole = 1.5 L; holes placed at distance L apart.

Hard granite:—L = 1.5 d or less; v not less than 1.5 h; h not more than 0.6 d. If h is more than 0.6 d holes must be closer together in a row.

MILITARY WOODEN UNTRUSSED BRIDGES

General formulae for determining the weight that may **pass over** any span. These are general working safe-load formulae from which may be found the WEIGHT a span will hold, moving load, or the NUMBER OF STRINGERS per span, knowing the span and the weight; or the SPAN, knowing number of stringers and total moving weight (or live load). The formulae allow for flooring, so neglect weight of same.

W = Weight in pounds of the moving load; its values, when solving for n are:—

Massed men.....W= 70 B L lbs.	Field wagons.....W=2500 x lbs.
Infy., single file.....W= 55 L lbs.	Light artillery.....W=3000 x lbs.
Infy., col. of 2's....W=110 L lbs.	Siege artillery.....W=5000 x lbs.
Infy., col. of squads.W=225 L lbs.	Motor trucks.....W=1000 Tx lbs.
Cav., single file.....W=125 L lbs.	Traction engines...W=1000 Tx lbs.
Cav., col. of 2's.....W=250 L lbs.	Herded animals...W= 55 L lbs.

K = Corrector constant, whose values are:—

Old existing bridges, K = 1.

New existing bridges, or new material, very soft wood, K = 1.1; medium wood, K = 1.26; hard wood, K = 1.42.

L = Length of span (or stringer) in feet.

b = Breadth of one stringer in inches.

d = Depth of one stringer in inches.
m = Mean diameter of one stringer (round) in inches.
n = Number of stringers to a span (if all are uniform).
x = Number of vehicles which can get on a span at one time, if x is less than unity neglect it.
T = Number of tons the vehicle weighs.
B = Breadth of bridge in feet.

Rectangular Stringers

$$W = \frac{b\ d\ n\ K\ (1000\ d - L^2)}{8\ L^2}$$

$$n = \frac{8\ W\ L^2}{b\ d\ K\ (1000\ d - L^2)}$$

$$L = \sqrt{\frac{1000\ b\ d^2\ n\ K}{8\ W + b\ d\ n\ K}}$$

Round Stringers

$$W = \frac{n\ m^2\ K\ (80\ m - 1.7\ L^2)}{L}$$

$$n = \frac{W\ L}{m^2\ K\ (80\ m - 1.7\ L^2)}$$

$$L = \sqrt{\frac{1000\ m^3\ n\ K}{12\ W + m^2\ n\ K}}$$

WOODEN BEAMS

Table of safe **quiescent loads** for horizontal rectangular beams of white pine or spruce **one inch** broad, supported at both ends, the load being equally distributed over the span. **Moving loads** take half value.

Span in feet	DEPTH OF BEAM IN INCHES										
	6	7	8	9	10	11	12	13	14	15	16
5	800	1090	1420	1800	2220	2690	3200	3750	4350	5000	5690
6	670	910	1180	1500	1850	2240	2670	3130	3630	4170	4740
7	570	780	1010	1290	1590	1920	2280	2680	3110	3570	4060
8	500	680	890	1120	1390	1680	2000	2350	2720	3130	3560
9	440	600	790	1000	1210	1490	1780	2090	2420	2780	3160
10	400	540	710	900	1110	1340	1600	1880	2180	2500	2840
11	360	490	650	820	1010	1220	1450	1710	1980	2270	2590
12	330	450	590	750	930	1120	1330	1560	1810	2080	2370
13	310	420	550	690	850	1030	1230	1440	1680	1920	2190
14	290	390	510	640	790	960	1140	1340	1560	1790	2030
15	270	360	470	600	740	900	1070	1250	1450	1670	1900
16	250	340	440	560	690	840	1000	1170	1360	1560	1780
17	230	320	420	530	650	790	940	1100	1280	1470	1670
18	220	300	400	500	620	750	890	1040	1210	1390	1580
19	210	290	380	470	590	710	840	990	1150	1320	1500
20	200	270	360	450	560	670	800	940	1090	1250	1420
21	190	260	340	430	530	640	760	890	1040	1190	1350
22	180	250	320	410	500	610	730	850	990	1140	1290
23	170	240	300	390	480	580	700	810	950	1090	1230
24	160	230	290	370	460	560	670	780	910	1040	1180
25	160	220	280	350	440	540	640	750	870	1000	1130
26	150	210	270	340	420	520	610	720	840	960	1090
27	150	200	260	330	400	500	590	690	810	920	1050
28	140	190	250	320	390	480	570	670	780	890	1010
29	140	190	250	310	380	460	550	650	750	860	980
30	130	180	240	300	370	450	530	630	730	830	950

This table has been calculated for extreme fiber strain of 1000 lbs. per square inch, being one-sixth the breaking strain, ordinary building timber of fair quality.

Oak and yellow pine will carry a load one-fourth greater.

When more accuracy is required, the weight of the beam itself must be deducted.

Care must be taken to let the beams rest for a sufficient distance on their supports to guard against crushing at the ends, especially in placing very heavy loads upon short but deep and strong beams.

For **moving loads** assume half the above values. For stringers of breadth greater than 1" multiply these values by the breadth of the stringer in inches.

ELECTRICAL DATA

Where cm—circular mil area; k—resistance of 1 mil foot of wire (for copper D. C. k—10.79 and for A. C. k—13; for iron wire k—63.35); L—length of circuit in feet (double it for 2-wire); e—volts drop on that circuit (both wires), usually e—3 for good lighting; C—current in amperes. Then:—

To find size of wire in cm to carry current along a wire with any given loss on the line:

$cm = (k \times L \times C) \div e.$

To find volts drop in any circuit

$e = (k \times L \times C) \div cm.$

To find power lost on a line

$Watts = (k \times L \times C^2) \div cm.$

To find the size of wire for a 3-wire circuit

$Cm = (k \times L \times C) \div 4e$; then make neutral wire half the size of outer wires.

To find resistance of a line

$R = (L \times K) \div cm.$

In lighting camps allow a voltage drop of about 2 to 3% of line voltage. Current requires in practice, in amperes:—

16 candlepower carbon lamp, 0.5; 55-watt lamp, 0.5; 100-watt lamp, 1; 150-watt lamp, 1.4; 200-watt lamp, 1.8; open air arc lamps, 8 to 10; relay circuit of telegraph line, 0.030; local sounder circuit of telegraph line, 0.25; moving picture machine, 60.

WIRE TABLE

Copper wire, weather proof, for camp circuits, not enclosed					Galvanized Iron Telegraph Wire (Roebling's) Best Best					
W. D. Size	Safe Amp.	No. in B. and S.	C. M. Area	Resist. per 1000 ft.	No. B. W. G.	Diam. Mils.	Weight 1000 ft.	Pounds per one mile	Resist. per mi ohms	Safe Tension Load
460	312	0000	211,600	.049	0	340	304	1607	3.42	Same values as 4th column, pounds.
410	262	000	167,800	.062	1	300	237	1251	4.4	
365	220	00	133,100	.078	2	284	212	1121	4.91	
325	185	0	105,500	.098	3	259	177	932	5.9	
289	156	1	83,690	.124	4	238	149	787	6.99	
258	131	2	66,370	.156	5	220	127	673	8.18	
229	110	3	52,630	.197	6	203	109	573	9.6	
204	92	4	41,740	.248	7	180	85	450	12.21	
182	77	5	33,100	.313	8	165	72	378	14.53	
162	65	6	26,250	.395	9	148	58	304	18.06	
128	46	8	16,510	.498	10	134	47	250	22.04	
102	32	10	10,380	.629	11	120	38	200	27.48	
81	23	12	6,530	.792	12	109	31	165	33.3	
64	16	14	4,107	1.	13	95	24	125	43.85	
51	8	16	2,583	1.26	14	83	18	96	57.44	
40	5	18	1,624	1.59	15	72	13.7	72	76.33	

STEEL AND IRON WIRE

Column (1) Steel wire gauge, size of; (2) W. D. sizes, diam. in mils; (3) Circular mil area; (4) Diam. in mils corresponding to B. W. G.

(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
4	225	50,625	238	12	105	11,025	109
5	207	42,849	220	13	92	8,464	95
6	192	36,864	203	14	80	6,400	83
7	177	31,329	180	15	72	5,184	72
8	162	26,244	165	16	63	3,969	65
9	148	21,904	148	17	54	2,916	58
10	135	18,225	134	18	47	2,209	49
11	120	14,400	120				

Solid wire to be equivalent to stranded cable:—Rule: find circular mil area of one wire of cable, multiply by number of wires, which will give total circular mil area of cable; look up in table the proper solid wire to correspond with this product just found. For use in determining amperage and tensile strength.

War Dept. sizes of wire:—W. D. sizes of wires are the diameters of those wires in mils.

Combining wires of different sizes:—For amperage or tensile strength. Rule: Add the circular mil area of the wires, then find the wire whose circular mil area is the sum just found.

Given diameter in mils to find circular mil area:—To get the circular mil area of any wire, square the number which expresses the diameter of the wire in mils; one mil equals .001 inch.

Sizes, B. & S. gauge, copper wire:—These bear a definite relation. i. e., two 0 wires equal one 0000, and each wire in the table is one-half the size of the third greater wire. Hence No. 7 equals two of No. 10.

The Watt:—One watt equals 44.25 footpounds per minute; 1000 watts equal 1 kilowatt; 1 kilowatt for one hour equals 1 kilowatt hour. Note that one 55-watt lamp burning for 18 hours, is $18 \times 55 = 990$ watts, or 0.99 kilowatt-hour.

Size of wire for D. C. motor:—P = rating in horsepower; L = distance in feet to motor; E = impressed E. M. F.; e = volts dropped in wiring; F = % efficiency of motor; Cm = circular mil area of wire. Then $Cm = (20515 \times P \times L) \div (e \times E \times F)$.

NAILS

Number and length in inches of common nails to the pound

Size	2d	3d	4d	6d	8d	10d	12d	16d	20d	30d	40d	50d	60d
Length...	1	1¼	1½	2	2½	3	3¼	3½	4	4½	5	5½	6
No. per lb.	900	500	300	168	90	60	48	36	24	18	13	10	8

STRENGTH OF ROPES AND CHAINS

P = safe load in lbs.; C = circumference of rope in inches; d = diameter of the link of a chain in inches, then:—

Manila ropes, hemp ropes, tarred hemp ropes.... $P = 100\ C^2$
Iron wire rope, 7 strands of 19 wires each..... $P = 600\ C^2$
Best steel wire rope, 7 strands of 19 wires each.. $P = 1{,}000\ C^2$
Wrought iron open-link chains..... $P = 12{,}000\ d^2$
Stud link chains..... $P = 18{,}000\ d^2$

A rule approximating the breaking load of new rope in tons of 2,000 lbs. is to take ¼ the square of the circumference in inches.

Strength of pieces from same may vary 25%. Manila rope and tarred rope are only about ¾ as strong as hemp rope. Ropes in daily use should never be worked up to greater than 1/5 their breaking loads. The size of rope is denoted usually by its diameter in inches. In the Navy the size is denoted by its circumference in inches.

To tighten a temporary lashing of rope or cord wet the rope or cord before lashing and then allow it to dry.

Power necessary to raise a weight:—Divide the weight by the number of parts of the "fall" at the running block. For friction and stiffness allow 0.1 the weight for each sheaf through which the "fall" runs. Each rope entering, leaving, and attached to the RUNNING block is termed a "fall." Or:—

Where n = number of movable pulleys; w = weight held; and p = force exerted—then $p = w \div 2n$. Or:—

For NEW manila ropes—diameters, ½", 500 lbs.; 1", 1,500 lbs.; 1½", 3,500 lbs.; 2", 5,500 lbs.; 2½", 7,500 lbs.; 3", 10,000 lbs.; 3½", 12,000 lbs.; 4", 14,000 lbs.

PHOTOGRAPHY

Table A gives correct time in seconds to use between 10:00 a. m. and 4:00 p. m., and refers to a No. 8 or (f 8) stop, or a No. 4 if U. S. is used. When using any other stop than f 8 (or 4 U. S.), multiply the fractions of seconds given in A by the factor given in Table B. Camera should be used on tripod for exposures longer than 1/25 second.

TABLE A	Number of Seconds	
	Sun	No Sun
Clouds	1/200	1/50
Distant views	1/100	1/25
Water and snow	1/50	1/10
Moving objects	1/50	
Landscapes, white objects, street scenes	1/25	1/5
Buildings, dark	1/10	1/2
Shady places	1/5	1
Indoors	8	15

TABLE B		
F.	U. S.	Factor
4.5	1.3	1/3
5.6	2.0	1/2
6.3	2.4	2/3
8.0	4.0	1
11.0	8.0	2
16.0	16.0	4
22.0	32.0	8
32.0	64.0	16
64.0	256.0	64

Pyro Formulae:—

No. 1.—Water, 7 oz.; Oxalic acid, 2½ grains; Pyrogallic acid, ¼ oz.
No. 2.—Water, 7 oz.; Sulphite soda, ¾ oz.; Carbonate soda. ½ oz.
Tray development:—No. 1, ½ oz.; No. 2, ½ oz.; water, 4 ozs.
Tank development:—No. 1, 1 oz.; No. 2, 1 oz.; water, 22 ozs. for 20 minutes at 65°F.; each degree colder add 1 minute, each degree warmer deduct 1 minute.

TOPOGRAPHY

To find length of scale and its subdivisions mechanically

Paces

Completed scale will be **2,000 paces long.**
S=total length of scale in inches, i. e., result desired.
R. F.=Maps Representative Fraction expressed as a **fraction.**
Y=number of paces to go 100 yards.
Then:—

$$S = R.F. \times \frac{7{,}200{,}000}{Y}$$

Time

Completed scale will be **5 minutes** long and is suitable to man, horse, vehicle.
S=total length of scale in inches, i. e., result desired.
N=number that expresses how many inches on the map = 1 mile, as "6" for 6" = 1 mile.
Y=number of **minutes** to go **1 mile.**
Then:—

$$S = \frac{5 \times N}{Y}$$

Revolution of wheels

Completed scale will be **500 revolutions** applicable to any wheel, not necessary to know wheel's diameter.
S=total length of scale in inches, i. e., result desired.
R. F.=Maps Representative Fraction expressed as a **fraction.**
Y=number of revolutions to go **100 yards.**
Then:—

$$S = R.F. \times \frac{1{,}800{,}000}{Y}$$

Note:—How to use these formulae: Determine Y (by pacing, time to go 1 mile, number of revolutions, etc.). Determine R. F. from data shown

in this book, or in usual manner. Solve for S. Lay out by a ruler (use scales in this book) the value of S in inches and decimals of an inch; divide this length into proportional parts by means shown in this book. Example:—S = 5.8 for **Paces**; hence a line 5.8″ long is 2,000 paces, divide in the middle, repeat, divide each part into 5 parts by eye and the latter will show 100 paces; subdivide 100 paces into smaller parts.

MAP READING

Representative fractions:—One divided by the first number is the **number of inches** equal to a mile shown by second number:—63,360, 1; 31,680, 2; 21,120, 3; 15,840, 4; 12,672, 5; 10,560, 6; 7,920, 8; 7,040, 9; 6,336, 10; 5,760, 11; 5,280, 12; 4,224, 15; 3,520, 18; 3,168, 20; 2,640, 24; 2,112, 30; 1,760, 36.

One divided by the first number is the **number of miles** equal to 1 inch shown by the second number:—63,360, 1; 126,720, 2; 190,080, 3; 253,440, 4; 316,800, 5; 380,160, 6; 500,000, 7.9; 1,000,000, 15.8.

Lengths represented by 1 inch on a map whose number of inches to 1 mile is the first number:—3—1,760 ft.; 586.66 yds.; 535.897 meters; 26.667 chains; 0.333 miles; and 1 sq. inch = 70.859 acres. 6—880 ft.; 293.33 yds.; 267.648 meters; 13.333 chains; 0.1667 miles; and 1 sq. inch = 17.715 acres.

Comparison of maps:—a refers to map "a," b refers to map "b." MD = map distance. VI = vert inter. SL = slope. SC = scale. Then MDa × VIb × SLa × SCb = MDb × VIa × SLb × SCa.

Visibility:—Let A and B be two points on map, and P be one on line A-B thought to obstruct visibility of A to B. Let x = difference in elevation of A and B, y = difference in elevation of A and P, expressed in same units; m = distance A to B, and n that of A to P (any scale). Then if n ÷ y is equal to or less than m ÷ x, B is visible from A, otherwise, not visible.

PLOTTING COMPASS READINGS

From **prismatic** compass readings:—Compass graduated with N-180°, E-270°, S-0°, W-90°, is plotted from a protracter graduated N-0°, E-90°, S-180°, W-270°. Compass graduated N-180°, E-90°, S-0°, W-270° is plotted from a protracter graduated N-0°, E-270°, S-180°, W-90°.

From **box** compass readings:—Compass graduated N-0°, E-90°, S-180°, W-270° is plotted from a protracter graduated N-0°, E-270°, S-180°, W-90°. Compass graduated N-0°, E-270°, S-180°, W-90° is plotted from a protractor graduated N-0°, E-90°, S-180°, W-270°. Compass graduated N-0°, E-90°W, S-0°, W-90°E is plotted from a protracter graduated same, reversing the "W" and the "E." Compass graduated N-0°, E-90°E, S-0° W-90°W is plotted from protracter graduated same, reversing "E" and "W."

THE ENGINEER'S LEVEL (or WYE Level)

Engineer's level:—To use it, set up and focus as described for the transit, except that, as there is but one level, the telescope must be turned in the direction of one pair of leveling screws and leveled, and then turned in the direction of the other pair and leveled again. The second leveling may disturb the first, which should be retested.

1st adjustment.—To fix the intersection of the cross wires in the axis of the telescope:

Lay the telescope exactly on some definite point. Revolve it in the wyes until the attached level is on top. If the horizontal wire now appears above or below the point, move it over half the space between its position and the point by the top and bottom reticle screws, and the other half by the main leveling screws of the instrument. Revolve the telescope in the wyes till it is again in the first position, and repeat the operation till the horizontal wire neither ascends nor descends when the telescope is revolved in the wyes. A similar process adjusts the vertical wire.

2d adjustment.—To make the axis of the attached level parallel to the axis of the telescope:

Clamp the level; turn the telescope in the wyes until it comes against the stop, and with the main leveling screws bring the bubble to the middle of the tube. Open the loops, lift out the telescope, put it back with

ends reversed, and turn it in the wyes till it comes against the stop again. If the bubble settles away from the middle of the tube, bring it back by raising the lower end, or depressing the higher end, one-half by the vertical adjusting screw at the end of the attached level, and one-half by the main leveling screws. Repeat all the operations until the bubble remains in the middle of the tube without reference to the way the telescope is placed in the wyes. The axes of the telescope and of the level are now horizontal but not necessarily parallel. Turn the telescope slowly in the wyes through a small angle. If the bubble does not remain at the middle point of its tube, bring it back by the horizontal adjusting screws of the attached level. If both parts of the adjustment are perfect, the bubble should now remain at the middle of its tube whether the latter is directly under the telescope or a little to one side. In practice it will be found difficult to complete the first part of the adjustment in a satisfactory manner independently of the second part. The best sequence is to make the first part roughly; then the second part carefully; then the first part again more carefully, and so on until the desired permanency of bubble position is attained.

3d adjustment.—To make the axis of the wyes perpendicular to the vertical axis of the instrument:

This adjustment is not essential, but it is a convenience, as it permits the telescope to be revolved about the vertical axis without releveling before a reading is made. Level the instrument in any position; revolve it 180° about the vertical axis and correct one-half the movement of the bubble by adjusting the movable wye. Repeat for a check. As a final check, level the instrument when the telescope is over one set of leveling screws. Revolve 90° and again level. The bubble should now remain in the middle of its tube while the instrument is slowly revolved about the vertical axis. To do accurate leveling it is necessary to check the adjustments frequently and make all observations with the greatest care.

Level rods are of two kinds, target and self-reading or speaking. The target rod is finely graduated and has a metal target sliding on it, which is graduated as a vernier. The levelman signals to the rodman, who moves the target up or down until it is in the right position, when the reading is taken by the rodman, or else the rod is carried to the levelman to be read. The ordinary form is the New York rod. The rod proper is in two parts, which slide on each other. For readings up to 6½ feet the target is moved on the rod and read from the graduation on the front part by a vernier on the target. For greater readings the target is clamped at 6½ feet and the back part of the rod slid up on the front part, the reading being taken from a scale on the side of the back part by a vernier on the side of the front part. The rod is graduated to 100ths of feet and the verniers read to 1000ths.

Use of the level:—The first sight to any point is the fore sight (F. S.), and a later sight to the same point from a new position of the instrument is a back sight (B. S.). All the elevations observed at any station depend upon the B. S. at that station. A bench mark (B. M.) is a point especially selected or prepared with a view to definiteness and permanency. A turning point (T. P.) is a temporary point used for a B. S. The plane of reference for each instrument station is the horizontal plane through the line of sight of the telescope, called height of instrument, (H. I.). A B. S. is a sight taken to a point of known elevation to determine H. I. A F. S. is taken from a known H. I. to determine the elevation of the point sighted on. The rod readings are the distances of points below the plane of reference, and for the same station their differences are the differences of level of the points themselves. For the difference of elevation of points observed from different stations the H. I. must be considered, and hence it must be worked out for each station and the rod readings subtracted from it.

Fore sights and back sights on the same point should be as nearly as possible of equal length.

Notes.—The clearest way of recording level notes is in the following form:

B.S. +	H. I.	F.S. —	El.	Station	Remarks
8.75	108.75	...	100.00	B.M. 21	NE. cor. Main and 12th streets.
...	.....	6.41	102.34	.....	Stake 132.
...	.....	3.28	105.41	.....	Center of 12th street at top of grade.
...	.....	5.37	103.38	.....	Center of 12th street at bottom of grade.
...	.....	9.74	99.01	T. P.	
7.60	106.61	...	99.01	T. P.	

Add the B. S. to the elevation of the B. M. or T. P. for the H. I. Subtract the F. S. from the H. I. for the elevation of a point. As a check, the H. I. at any B. M. or T. P. plus the F. S. to that point, minus the B. S. from that point, equals the last preceding H. I.

THE ENGINEER'S TRANSIT.

To use the transit, set up the tripod, remove the cap from the tripod and screw on the instrument in its place. Hang the plumb line on the hook depending through the tripod head, and adjust its length to bring the point of the plumb bob as close as possible to the setting point. Unclamp the vernier and turn the transit so that one of the plate levels is parallel to one pair of leveling screws. The other plate level will be parallel to the other pair. Bring the bubbles of the levels to the center in succession by means of the leveling screws. Always turn one of a pair down as the opposite one is turned up and avoid more pressure of the screws against the plate than is necessary for a firm bearing. If a screw turns hard at any time it is either sprung or has been set up too tight. In turning a pair of leveling screws always move the thumbs toward each other or away from each other. The bubble will follow the motion of the left thumb.

With the level bubbles in the centers of their tubes, the plate will be level if the bubbles are in adjustment. Turn the transit slowly in azimuth and watch the bubbles. If they remain in the centers, the plate is level and the levels are also correct. If either bubble leaves the center, the amount of its motion indicates the amount by which it is out of adjustment. If the amount is small it may be neglected; if large, the adjustment should be made as hereafter described. For short lines the level error may be neglected if the entire bubble remains in sight during the entire revolution. Adjust the leveling screws in this case so that the travel of the bubble will be equal on both sides of the center.

Having leveled the plate, draw out the eyepiece until the cross hairs are clearly defined. The instrument is now ready for use or adjustment. Adjustments should be invariably made in the order in which they are described.

1st adjustment.—To make the axes of the plate levels perpendicular to the axis of the instrument and therefore parallel to the plate:

Having set up and leveled, clamp the limb and revolve the plate 180°. If either bubble recedes from the middle of its tube, bring it back by raising the lower, or depressing the higher end, one-half by the main leveling screws, and one-half by the small screws which fasten the level to the plate. Again revolve the plate 180° and if the bubble still recedes from the middle, correct the error as before and repeat the operation until the bubble does remain in the middle in both positions of the plate. When the adjustment is complete, both bubbles will remain in the center with the plate in any position.

2d adjustment.—To place the intersection of the cross wires in the straight line through the optical center of the object glass and perpendicular to the horizontal axis of the telescope:

The first adjustment completed, direct the telescope to some small, well-defined, and distant object. With the screw which moves the object-glass slide adjust the latter so that the distant object is as distinct as possible. Both cross wires and object should now be clearly seen. Note whether the image appears to move with reference to the wires when the eye is moved from side to side across the opening of the eyepiece. Such displacement is called parallax, and indicates that the image is not

exactly in the plane of the cross wires. Move the object glass by its thumb-screw until the parallax ceases. This must be done every time the transit is used to read an angle, as well as when adjusting it.

Unclamp the plate and lay the intersection of the wires upon the middle of a pin 200 or 300 ft. distant; clamp the plate; plunge the telescope, that is, revolve it about its horizontal axis, and have a pin driven at the same distance from the transit so that its middle shall be seen exactly at the intersection of the cross wires. Revolve the plate 180°; clamp and lay exactly upon the middle of the first pin. Again plunge the telescope and look at the second pin. If the intersection again strikes the pin the adjustment is correct, but if the pin appears to one side of the intersection, bring it back one-quarter of the way by the side reticle screws, turning one in as the other is turned out. If the instrument is **erecting** (most transits are) loosen the reticle screw on the side toward which the wire should move in the field and tighten the other one. If **inverting**, turn the other way. Repeat the process until the pins are cut exactly in the middle without reference to position of transit or telescope. The adjustment will then be correct.

3d adjustment.—To make the horizontal axis of the telescope perpendicular to the vertical axis of the instrument:

The instrument leveled, lay the telescope on a point at the top of a nearly vertical line, such as the corner of a building or a steady plumb line. Clamp the plate and depress the telescope until the horizontal wire is near the lower end of the vertical line, and note the position of the intersection of the wires with respect to the selected vertical, whether to right or left of it, and how much. Revolve the plate 180°; plunge the telescope, and again bring the intersection of the cross wires on the top point of the selected vertical; again depress the telescope and bring the horizontal wire to the bottom of the vertical. If the intersection of the wires is again on the same side and at the same distance from the selected vertical the adjustment is correct. If it is not so, raise or lower the movable support by the proper adjusting screws so as to correct half the difference, and repeat the operation. If the instrument is erecting, raising the support will move the intersection away from it; or lowering the support will move the intersection toward it. If inverting, the reverse.

4th adjustment.—To make the vertical wire perpendicular to the horizontal axis:

Level carefully and lay the top of the wire on a definite point. Elevate the telescope slowly and note whether the point remains on the wire. If not, loosen two **adjacent** reticle screws and tap the head of one very gently until the point will travel on the wire from end to end. Then tighten the screws. If gently tapping on a screw head does not move the wire, tap on the opposite side of the opposite screw.

For a transit without vertical limb or attached level, known in the trade as a plain transit, the adjustments are now complete. If the transit has an attached level, its axis is made parallel to the line of sight by the—

5th adjustment.—Set up midway between two stakes, which have their tops at about the same elevation, and with the bubble of the attached level in the center, read a rod on each stake. The difference in the readings is the true difference in level of the tops of the stakes. Move the instrument toward one of the stakes, and set it up so that the eyepiece is about over the center of the stake. Place the rod on the stake near the eyepiece, and set the target in the middle of the field as seen through the **object glass.** Set up the rod on the far stake with a target set at the reading just taken through the object glass, plus or minus the difference of level between stakes—plus if lower, minus if higher. Bisect the target with the horizontal cross wire. The line of sight must now be horizontal, and keeping the vertical motion clamped so as to retain the pointing, adjust the bubble of the attached level to the center by means of the small screws at the movable end of its tube. Both line of sight and axis of bubble are now horizontal and therefore parallel.

Note that the position of the horizontal wire in the field is a matter of convenience mainly. It is best to have it near the middle of the field and it can be placed there by inspection with all needful precision.

6th adjustment.—If the transit has a vertical limb in addition to the attached level, the line of sight and axis of the attached level made parallel to each other by the preceding adjustment should also be so

adjusted that the vertical scale will read zero, when they are horizontal. If the vernier of the vertical limb is adjustable, bring the bubble of the attached level to the center and then adjust the vernier to read zero. If the vernier is fixed, the reading, when the attached level is horizontal, may be taken as an index error and applied to all readings, or the line of sight may be adjusted to the vernier. To do this, establish a horizontal line from the center of the level to the target, as explained in the preceding adjustment. Set the vertical limb so that the vernier reads zero, and bring the intersection of the wires on to the target by the top and bottom reticle screws. Then keeping the intersection on the target, bring the bubble of the attached level to the center by its adjusting screws. The line of sight and the axis of the attached level are now parallel, and are horizontal when the vertical limb is at zero, which completes the adjustment.

Use of the transit:—To measure a horizontal angle, set up over the vertex of the angle to be measured, and direct the telescope along one of the sides of the angle. Clamp limb and plate—if the latter is set at zero it is more convenient—and with the tangent screw of the limb bring the intersection of the cross hairs on a definite point of the line. Read each of the two verniers and record, calling one vernier A and one B. Unclamp the plate—not the limb—and direct the telescope along the other line. Clamp and bring the cross hairs to a definite point with the vernier tangent screw. Read and record as before. Take the differences of the two readings A and B, respectively. If these differences are the same, it is the value of the angle. If not, take the mean of the differences as the value. For greater accuracy, the method of repetition is used. After the first measurement is made, unclamp the limb—not the plate—and resight on the first point by means of the limb tangent screw, and proceed as before. The reading of the vernier is now twice the angle. Continue the repetitions until the desired number is made. The last reading divided by the number of measurements is the value of the angle. To guard against errors, it is well to read and record after each measurement.

To measure a vertical angle:—Point the instrument; clamp the horizontal motions and make the readings on the vertical limb. For greater accuracy when there is a complete vertical circle, revolve the instrument through 180°, plunge the telescope, and take new readings. If the results differ, use the mean.

To run out a straight line:—Set up accurately over the initial point. Point the telescope in the required direction, and establish a second point. These two determine the line which is to be run out. Set up over the forward, or second point; lay the telescope on the initial point; clamp limb and plate; plunge telescope and set a point forward. If the adjustments are good, this third point will be in line with the first and second and the line may be prolonged by repeating the steps taken at the second point.

If the adjustments are not good, set a third point as before. Then unclamp the limb and turn 180° in azimuth and lay on the initial point. Clamp and plunge again and set another third point beside the first one. Take the middle point between the two for the true third point. This method eliminates errors of adjustment, except those of the plate levels. These are so easily observed and corrected that they should never exist when close work is required.

Traversing:—The transit must be set at each station with the 0-180° line of the azimuth circle parallel to its position at preceding stations. This is called carrying an azimuth. The direction chosen for the 0-180° line is usually the true N. and S., or as near it as data at hand will permit.

Having observed the second station from the first, proceed to the second, set up, and set one of the verniers at its reading from the first to the second station, plus 180°, or at the back azimuth. Point at the first station and clamp the limb. The line 0-180° is now in a position parallel to that at the first station. Unclamp the plate, direct the telescope to the third station and proceed as before.

Stadia surveying, or stadia work, is in theory the determination of the distance of an object along the line of sight from the size of its image in a telescope. In usual practice, it is the determination of the distance from the size of the object at that distance which is required to produce an image of a fixed size in the telescope. The sizes of objects required

to produce an image of fixed size are directly proportional to their distances from the point over which the telescope is set. This hypothesis is not rigidly correct, but the theoretical error is small and the practical errors negligible.

To Locate Magnetic Meridian:—

Place a table, level, in the sunlight, long diameter of table approximately north and south. At south end of table erect a vertical board, 1½ ft. long for summer, 2 ft. long for winter months, edges east and west. At top edge of board tack a heavy piece of paper or tin, and bend it toward the north end of the table so it makes an angle of about 30° with the board. Prick a small hole in the center of this paper or tin, so as to throw a sun spot on the table in the board and paper's shadow. From 11:30 a. m. to 12:30 p. m., plot the curve of the sun spot, 5 minute intervals, on the table. Drop a plumb line from the hole in the paper to the table and mark spot where plumb-bob touches table. Call this A. With A as a center and a convenient radius, draw the arc intersecting the plotted sun spot path. Let C and D be these intersections. Draw line CD; bisect it, call point of bisection E. Draw AE. The line AE is the true north and south line or meridian, A being south, E being north.

MILITARY ROADS

The best form for upper surface of road is that of two planes inclined at an angle of about 1 on 24, and joined by slight curve 5 feet long. On a hillside the surface should be a single plane inclined towards the hill. Between the road and ditches should be flat mounds raised 6 inches or more above the surface, with sloping sides covered with sod or stones next to the road, thus forming, with roadway, the gutters; they serve also to hold up the road material and as warning at night of the proximity of the ditch.

Usual **width** 18 ft.; 16 ft. sufficient for passing of vehicles; 10 ft. sufficient for wagons in single file. Average **grade** is 3°; long grades not over 2°; short grades may be 6°. **Crown** should be 6 inches. Top of an **embankment** should be 5 ft. wider than proposed road; slope 1½ on 1 is max; allowance for settlement is 1/10 the height. For **cuts**, slope of 1½ on 1 is max. To construct **Macadam** road:—Roll and thoroughly pack sub-grade; lay bottom course 6 inches thick of 2¼ to 2½ inch stone and roll it down to 5 inches or less; lay top course 4 inches thick of ½ to 1¼ inch stone and roll it down to 3 inches. Spread layer of screening to cover projecting stones, wet it and roll it. To construct **Telford** road, lay bottom course of large stones by hand, then finish as for macadam road. Use of **roller**:—Roller to be not less than 4 ft. in diameter and weigh not less than 1 ton; roll sides first, then center; sprinkle ahead of roller. Cost:—Earth embankments and cuttings, 20 cents per cu. yd. and ½ cent per 100 ft. of haul. Gravel $400 and macadam $500 per mile 1 inch thick; earth roads $350 per mile. Clearing costs $10 to $50 per acre or $20 to $100 per mile. It takes 4 minutes to fill a wagon with dirt using 6 shovels per wagon. Allow 10 men for dumping and spreading. Place grade stakes every 100 ft. with side stakes opposite. Broken rock occupies 75% more volume than before broken. Rock taken from a cut will make a like embankment 50% longer. Drilling and blasting, use 5 lb. sledge, holes 6 inches deep and ⅞ inch in diameter.

PACK TRAILS

Drain well. Good foot trail made by laying two lines of logs 18 inches apart from inner surfaces, well pegged down. Fill with small sticks and tamped earth. In jungle allow 20 feet of width in clearing, to allow for sun to dry the trail.

TENTAGE

Note:—One large tent pin is 24 inches long and weighs 12 ozs.; one small pin is 16 inches long and weighs 7 ozs.

Hospital (tropical) Wall:—1 tent; 1 fly; pins, 36 large, 26 small; poles, 1 ridge tropical, 2 sections, 2 uprights regulation, 4 uprights small; 1 stove; 1 shield G. I.; 2 elbows; 6 joints stovepipe; 1 spark arrester. Length 14′ 3″, guyed 23′; Width 15′ 7″, guyed 36′; Height 12′; Height of wall 4′ 7″; Length of fly 25′ 6″; Width of fly 18′ 4″; Length of

ridge pole 18′; Length of upright for ridge 12′, for wall 4′ 8″. Weights, pounds, tent 125, fly 44, poles 97, pins 37, complete 303. Floor space 222 sq. ft.; Max. No. of cots 8; Distance center to center for pitching 36′; No. of tents in 100 yards 8 1/3. Cubic feet when folded, with fly 10.

Pyramidal, large:—1 tent; pins, 28 large, 28 small; 1 pyramidal pole; 1 tripod; 1 stove; 5 joints pipe; 1 spark arrester. Length 16′, guyed 22′; Width 16′, guyed 22′; Height 11′; Height of wall 3′; Length of pole 7′ 9″. Weights, pounds, tent 107; pole and tripod 42; pins 32; complete 181. Floor space 256 sq. ft. Max. No. of cots 10; Distance center to center for pitching 24′. Number of tents in 100 yds. 12. Cubic feet when folded 5.1.

Wall, small:—1 tent; 1 fly; pins, large 18, small 26; poles, 1 ridge, 2 uprights regulation; 1 stove; 1 shield G. I.; 2 elbows; 7 joints pipe; 1 spark arrester. Length 9′ 2″, guyed 16′ 6″; Width 8′ 11″, guyed 20′; Height 8′ 6″; Height of wall 3′ 9″; Length of fly 15′ 6″; Width of fly 11′ 6″; Length of ridge pole 11′ 4″; Length of upright 9′. Weights, pounds, tent 47, fly 18, poles 30, pins 24, complete 119. Floor space 81 sq. ft. Max. No. of cots 3; Distance center to center for pitching 20′. Number of tents in 100 yards 15. Cubic feet when folded, with fly, 4.

Ward:—1 tent; pins, large 68, small 52; poles, upright regulation 4, small 4; 4 stoves; 28 joints pipe; 4 spark arresters. Length 49′, guyed 62′; Width 17′ 6″, guyed 30′ 6″; Height 11′; Height of wall 4′. Weights, pounds, tent 351, poles 72, pins 74, complete 497. Floor space 857 sq. ft. Max. No. of cots 24; Distance center to center for pitching 34′ 6″; number in 100 yards 8. Cubic feet when folded 24.

Storage:—1 tent; 1 fly; pins, large 44, small 38; poles, ridge jointed 1, uprights regulation 3, uprights small 8; 1 stove; 1 shield G. I.; 2 elbows; 7 joints pipe; 1 spark arrester. Length 20′ 5″, guyed 26′; Width 17′ 10″, guyed 40′ 6″; Height 13′; Height of wall 5′ 2″; Length of fly 25′; Width of fly 20′ 5″; Length of ridge pole 20′ 3″ (in 2 sections); Length of uprights for ridge 13′ 11″, for wall 6′. Weights, pounds, tent 170, fly 48, poles 111, pins 49, complete 378. Floor space 222 sq. ft. Max. No. of cots 10; Distance center to center for pitching 40′. Number in 100 yards 7½. Cubic feet folded, with fly 12.

Shelter:—2 halves; 10 pins shelter. Distance center to center for pitching allow 5′ 9″. Number in 100 yards 45.

WEIGHTS OF FIELD ARTICLES, AND NUMBER IN STANDARD PACKAGES

The first number represents the weight of the article, and the second number represents the number of articles in a standard package, box, or crate.

Arresters, spark 11 ozs.—70; Axes 3 lbs. 8 ozs.—12; Bags, surplus kit 4 lbs. 10 ozs.—10; Bars, mosquito, single 1 lb. 9 ozs.—100 also 15; Blankets, L. W. 3 lbs. 1 oz.—12; Brooms, corn 2 lbs. 12 ozs.—12; Brushes, scrubbing 12 ozs.—105; Cots 20 lbs. 13 ozs.—5; Covers, cot 2 lbs. 3 ozs.—30 also 75, mattress 2 lbs. 10 ozs.—50 also 30; Desks, field 26 lbs. 8 ozs.—5; Flies, tent (see tentage); Handle, shovel, long 1 lb. 13 ozs.—12, short 1 lb. 7 ozs.—12, spade 1 lb. 14 ozs.—12; Hatchets 1 lb. 4 ozs.—100; Helves, axe 1 lb. 6½ ozs.—50, hatchet 5 ozs.—250, pickaxe 2 lbs. 4 ozs.—24; Lockers, trunk 31 lbs.—1; Mattresses 20 lbs.—5; Pickaxes 7 lbs. 1 oz.—18; Pillows 3 lbs.—20; Pins, tent, small 7 ozs.—260, large 12 ozs—150, shelter, aluminum ½ oz.—1,000; Poles, tent (see tentage); Rolls, bedding 12 lbs. 13 ozs.—4, clothing 4 lbs. 8 ozs.—14; Sacks, bed 2 lbs. 2 ozs.—; Shovels, long handled 5 lbs. 12 ozs.—6, short handled 5 lbs. 12 ozs.—6; Spades 5 lbs.—6; Stoves, tent 23 lbs.—5; Stovepipe, tent, elbow 14 ozs.—42; joints 2 lbs. 6 ozs.—50; Tents (see tentage); Tent chains and plates 2 lbs. 2 ozs.; Tent tripods 20 lbs.; Cleavers 2 2/3 lbs.—6; Cutters, meat 17⅞ lbs.—6; Dippers, small 5/12 lbs.—100, large 2½ lbs.—40; Forks, meat 9/16—250, table 11/96—972, carving 7/24—168; Graters 1 lb.—50; Knives, bread 11/24—120, butcher 1/3 lb.—216, carving 5/12 lb.—120, table 1/6—360; Ladle, soup 1/48 lb.—100; Mills, coffee 35 lbs.—3; Openers, can 5/24—276; Pans, dish 3¾ lbs.—12, frying 3 1/12—60; Saws, meat 2 11/24 lbs.—12; Scales and weights 25¼ lbs.—1; Sieves, flour 1½ lbs.—40; Skimmers 47/48 lbs.—50; Spoons, basting 11/24 lbs.—200, table 25/192 lbs.—550, tea 3/48 lbs.—1,800; Steels, carving 13/24 lbs.—48, butcher ¾ lbs.—60.

INTRENCHING:—

Men, Tools, Intervals, etc.—

With both arms extended men are at 5 ft. intervals and with one arm extended, 3 ft. intervals. With park tools men work at 5 ft. intervals and with intrenching tools at 3 ft. intervals, and resulting excavations are the same in a given time.

Allow 2 ft. of trench for one rifleman.

The output of intrenching tools is 3/5 that of park tools in the same length of time.

For measurements, consider:—Long-handle shovel handle 51 inches; Long-handle shovel, approximately 5 ft. or one task; Short-handle shovel, handle, 27 inches long; Pick handle, 36 inches long; Intrenching (shovel) tool, 22 inches long; Intrenching (pick) tool, handle only, 17 inches long.

In wire entanglements, allow 1 pound of staples per 8 sq. yds. of entanglement.

In overhead cover allow 8 inches of earth on thin boards for protection from shrapnel and 3 feet of earth on 6 inch timber as minimum protection against light siege artillery.

TRENCHES:—

Best protection is afforded by deep, narrow, inconspicuous trenches with cleared fore-ground. If time, troops and tools are available construct also (in following order):—

Head or overhead cover and concealment.

Placing obstacles and obtaining ranges.

Cover trenches for Supports and Local Reserves.

Communicating trenches, and deepen other trenches.

Bomb proofs, rears, dummy trenches, ammunition pockets, magazines, drainage and stairways.

Fire effect is first consideration. Intrench when compelled to halt for considerable time or whenever cover will be of use. Profile and construction are secondary to location and correct tactical use. Construct with a view to giving cover so as to diminish losses and permitting free use of rifle. Keep filled sand bags in trenches to form loop-holes, etc., and to repair works. Trace depends upon ground and proposed density of entire firing line. Lay out trenches in company lengths if possible, giving adjoining trenches mutual support. Protect flanks and important gaps in line by fire trenches echeloned in rear. To locate trace, lie on ground at intervals and select best field of fire consistent with requirements of situation. Select profile to permit fire to sweep foreground, requiring minimum of labor and time and giving best concealment. In selecting type give due regard to terrain, enemy, time, tools, materials, soil, time of occupancy, and fire expected. For passive defense, allow minimum of 1½ men per yard. Advanced trenches may be continuous and of wavy line construction.

Hasty Cover:—Quickly throw up low parapet 3 feet thick; protection against rifle but not shrapnel fire. May be developed in time, particularly at night, into deep fire or cover trench. Prone trench.

Fire Trench:—Constructed preferably with some head or overhead cover and communication with supports. Is deep and narrow and has flat, concealed parapet. In ordinary soil and on a basis of 2 reliefs and tasks of 5 feet it can be constructed in about 2 hours with intrenching tools. Simplest form is parapet 1 foot high, 9 feet long; elbow rest back of parapet, 1 foot wide; trench 2½ feet wide at top, 1¾ feet wide at bottom and 3½ feet deep. Standing trench. Not placed on prominent crest.

If constructed in this way it can be developed into a more complete form in 2 hours, with larger and deeper trench, foot-holds, loop-holes, notches, head cover, concealed parapet, and interior conveniences. Obstacles should not be more than 300 yards from fire trench nor closer than 75 yards.

Cover Trench:—Construct 1 for each 1 or 2 Fire Trenches, and placed as close to them as practicable. Simple, and rectangular in profile. Generally concealed by the contour of the ground or natural features. Overhead cover is frequently advisable. Made as comfortable as possible to provide cooking and resting facilities for garrisons of the corresponding fire trenches. Area:—Allow 6 square feet per man floor space.

Communicating Trenches, and Ways:—Make use of natural communications if present, otherwise construct. Necessary to connect Fire and Cover trenches. Rectangular in profile, deep, and narrow. Traversed, or zigzagged to prevent enfilade. Provide returns or pockets for latrines, storerooms, magazines, dressing stations, and passing points for troops in trenches.

Dummy Trenches and Parapets:—Any type which presents suitable appearance, of a real trench imperfectly concealed. These draw enemy's fire, and thereby protect real trenches. Waste earth from real trenches may be used in construction.

REVETMENTS:—

Applied to interior slopes of parapet and traverses. Upper parts of revetment should not be made of materials of large units or which splinter when struck; this upper part is called "crowning."

Sand Bag Revetments:—The sand bag is 33 inches long and 14 inches wide when empty. It requires about ½ cubic foot of earth or sand to loosely fill it. When put in place, flattened with shovel into rough rectangular form, the resulting form is approximately 20″ x 13″ x 5″. Empty sand bags weigh 62 pounds per 100, and 65 pounds each when filled. Are laid as stretchers and headers, breaking joints, tied ends inside; top row being of headers. Good for repair of parapet.

Squad of 6 men with 2 shovels, 1 pick, 1 bag-holder, and 2 tiers, can fill 150 bags per hour.

Squad of 16 men, 6 to fill, 6 to carry, and 4 to lay, can place 150 bags or 75 square feet of revetment per hour.

Sod Revetment:—Convenient size is 18″ x 9″ x 4½″—if tough, larger. Length always twice the width. Should be laid, grass down, in courses, breaking joints, and alternate layers of headers and stretchers, the latter double with broken joints. The bed for the bottom course is prepared so as to give the correct pitch; top course, grass up, and all headers. If sod may slip use wooden pins. A good slope is 3 to 1. Count on 450 sods to 100 square feet of revetment. If grass is long mow before cutting sods.

One man can place or cut 30 sods per hour. A sod plow cuts as fast as 50 men. Ice plows can be used as sod plows.

Brush Work:—Cut into bundles, 40 to 60 lbs. each. A rough average is 6 bundles per man per hour.

Fascine:—A closely bound cylindrical bundle of brush, 18 feet long, 9 inches diameter, when compressed. May be subdivided and cut into 2 or 3 equal parts. Average weight 140 lbs. Made in cradle of 5 trestles, each trestle being made of sticks 6½ feet long and 3 inches in diameter, driven into ground at equal angles to each other and lashed at intersections. End trestles 16 feet apart and parallel; intermediate trestles 4 feet apart.

Fascine choker bars, 4 feet long, jointed at 18 inches from ends by chain 4 feet long, marked at 14 inches each way from middle by special link or ring. Fascine bound in 12 places 18 inches apart, end binders being 3 inches outside end trestles. 66 lineal feet of binder required for each fascine—wire, tarred rope, or withes.

After cradle is made 4 men make 1 fascine per hour with wire bindings—withes require 1 man more.

Fascine revetment should have headers and anchors and a crowning of sods or sand bags.

Hurdle:—Is a piece of wicker basket work 2′ 9″ x 6′, and is made by describing on the ground arc of circle of 8′ radius, driving 10 pickets 8″ apart covering 6′ of the arc out to out; woven with brush. Wire stitching advantageous.

3 men construct 1 hurdle in 2 hours.

Continuous Hurdle:—Drive pickets 12″ or 18″ apart at proper slant 2′ 9″ high, weave with brush and stitch with wire.

2 men construct 4 yards in 1 hour.

Gabion:—Is cylindrical basket, open at both ends, 2′ 9″ high and 2′ in diameter. Use gabion form of wood, 21″ in diameter, with equidistant picket notches around circumference, normally 8 to 14 in number.

Pickets 1¼ to 1¾ inches in diameter, 3′ 6″ long, sharpened half at each end. In constructing gabion revetment use fascines, anchoring back same, and crown with sod or sand bags.

3 men should make 1 gabion in 1 hour.

BARRICADES:—

Wire Entanglement. High Wire:—Stakes are set 6 feet apart, are 9 feet long, set 3 feet in ground and 6 feet out. Entanglement is 10 yards deep, and it takes 10 men 1 hour to construct 1½ lineal yards. Tools:—2 mauls, 4 wire cutters, 4 picks, 4 hatchets, 1 measuring rod. Estimate 2 stakes and 100 yards of wire per lineal yard of 10-yd.-deep entanglement. **Low wire:**—Stakes set 4 to 6 feet apart, are 2 to 3 feet long, set half their length in ground. Entanglement is 10 yards deep, and it takes 10 men 1 hour to construct 9 lineal yards. Tools:—2 mauls, 4 wire cutters, 4 picks, 4 hatchets, 1 measuring rod. Estimate 2 stakes and 90 yards of wire per lineal yard of 10-yd.-deep entanglement.

TARGET PRACTICE

BATTLE SIGHT:—

Trajectory and line of sight coincide (for a normal rifle) at 530 yards.

The aiming point is the following inches below the point desired to be struck: at 200 yds., 25; 300 yds., 28; 350 yds., 26; 400 yds., 23; 500 yds., 7.

Good practicable rule:—Hold below the silhouette figure, at all ranges except 500, a distance equal to the apparent height of the figure at that range, and at 500 yds. ¼ this amount. This rule for field prone targets, but for D target aim at bottom of target at 200 and 300 yds. and width of two hands below silhouette at 500 yds.

Aim ahead of the point desired to be struck on a target moving at right angles to line of sight and traveling at a rate of 100 yards a minute as follows: at 200 yds., 15 inches; 300 yds., 25 inches; 500 yds., 40 inches.

ELEVATION CORRECTION:—

The Square Rule:—

Square the range; the result is the number of inches on the target that will correspond to a change of 100 yards on the sight leaf. Note:—By "range" is meant that number which expresses how many hundreds of yards, as 6 for 600.

A change of 50 yds. on sight leaf gives ½ the above correction in inches, and a change of 25 yds. gives ¼.

The "Bull's eye" Correction:—

The change of elevation (approximate) to move the bullet the diameter of the bull's eye on bull's eye targets at the various ranges is:

At	200 yds.	range move in elevation	200	yds.
At	300 yds.	range move in elevation	100	yds.
At	500 yds.	range move in elevation	100	yds.—.
At	600 yds.	range move in elevation	50	yds.+.
At	800 yds.	range move in elevation	50	yds.+.
At	1,000 yds.	range move in elevation	25	yds.+.

Note: + means take a little more, — means take a little less.

WINDAGE CORRECTION:—

"Quarter Point" Rule:—

Changing the windage ¼ point moves the bullet 1 inch on the target for every 100 yards of range.

Modification of "Quarter Point" Rule (sufficiently close for the average shot):—

Changing the windage 1 point moves the bullet the width of the bull's eye (on all bull's eye targets, and at all ranges).

The two above rules have nothing to do with **WIND.**

Rule to ascertain how much windage to take to correct for an estimated wind. Rule:—Multiply the range by the velocity of the wind in miles per hour and divide by 40; the result is the number of points of windage to take. Note:—By "range" is meant that number that expresses how many hundreds of yards, as 6 for 600.

This rule is sufficiently close for all side winds, but for winds from 1, 5, 7, and 11 o'clock take half the above value.

The following table is more accurate:

Range, yds.	For a side wind, miles per hour					
	5	10	15	20	25	30
200	¼—	½—	½+	¾—	1	1¼—
300	¼+	¾—	1	1½—	1¾	2 +
350	½—	¾+	1¼—	1½+	2	2½—
400	½—	1 —	1¼+	1¾+	2¼	2¾—
500	½+	1¼—	1¾+	2½—	3	3½+
600	¾	1½	2¼	3	3¾	4½
800	1¼—	2½—	3½+	4¾+	6	7¼—
900	1¼	2½	3¾	5	6¼	7½
1,000	1½—	3 —	4¼+	5¾+	7¼	8¾—

Note: + means a little more, — means a little less than value given. The values in the table are points of windage. For a 1, 5, 7, and 11 o'clock wind take half the above values.

ATMOSPHERIC CORRECTIONS:—

Barometer : Shots strike lower if the barometer is high.
Temperature : Shots strike lower on a cold day, higher on a hot day.
Moisture : Shots strike lower on dry days, higher on damp days.
Light : Shots strike lower on a dark target, higher on a bright one.
Shots strike lower when sights are brightly visible, higher when sights are less distinct.
Mirage : Shots will strike in direction of apparent movement of mirage. Correct by moving windage (or elevation, or both) against the mirage.
Wind : Shots will strike in the direction the wind is blowing. Correct by moving the windage against the wind.
Shots strike lower with a 12 o'clock wind, higher with a 6 o'clock.

WIDTH OF REAR SIGHT LEAF IN MILS:—

Assuming that a mil is one-onethousandth of the range, the rifle being in the position of aim, the width of the rear sight leaf (raised) is approximately 50 mils (or 1/20 of the range at all ranges).

SMALL ARMS AMMUNITION

60 cartridges = 1 bandoleer; 20 bandoleers in one box, or 1,200 cartridges. Box weighs 112 lbs., dimensions are 34.5 x 9.5 x 8.27 inches. Color bands on ammunition boxes:—red, ball; blue, blank; green, dummy; brown, gallery; orange, guard.

Rifle:—Muzzle velocity 2,700 feet per second; length complete, 43.412 inches; weight 8.69 lbs., weight of bayonet 1 lb. Point blank danger space, standing 407 yards, kneeling 324.6 yards, sitting 227 yards.

Protection against Small-arms fire (range over 200 yards):—Sand 30″; earth 39″; boggy or turfy ground 60″; 1 gabion filled with earth; 3 well made fascines; sand bags well packed, header, 1 bag, stretcher, 2 bags; stacked sod, 79″; soft wood 40″; oak or hard wood 30″; iron plate 7/16 ″; steel plate ¾″; masonry, brick work with broken joints 8″; cribs of broken stone 9″; ¼ to ½ inch best tough steel.

DIGEST OF SECURITY AND INFORMATION

ADVANCE GUARD:—Company:—(a) point, 1 N. C. O. and 4 Pvts.; (b) advance party, rest of first platoon; (c) support, 2nd and 3rd platoons; (d) flank guards from support. **Battalion:**—(a) point, 1 N. C. O. and 4 Pvts.; (b) advance party, 3 to 8 squads; (c) support, 2 companies less point and advance party; (d) reserve, 2 companies. (e) flank guards if necessary. Reserve may be omitted, then point is 2 squads, advance

party is 1 company, rest is support. **Regiment:**—(a) point, 1 N. C. O. and 4 Pvts.; (b) advance party, 1 company less point; (c) support, 3 companies; (d) reserve, 2 battalions. (e) suitable flank guards. **Mounted Point:**—If any, precede dismounted point by 250 to 600 yds., and advance party increased in strength. **Machine Guns:**—For one battalion, are with the reserve; For two or more battalions, are with the support. **Strength of:**—From 1/20 to 1/3 entire force. **Intervals and Formations:**—No fixed rules. Such as to allow next rear element time to deploy and leading element not to be cut off. In large advance guards, 400 yds. point to advance party, 500 yds. to support, 1,000 yds. to reserve, 1 to 2 miles to main body.

REAR GUARDS:—Similar in strength to advance guard; similar formations in reversed order; consists of rear point, rear party, support, and reserve. Should be strong in Cavalry; should have machine guns; Reserve formed of Infantry and Artillery; Mounted Engineers with rear party.

FLANK GUARDS:—As small as possible in strength If a regiment or less in strength it should be, not to exceed one mile from the main body; composed of Cavalry if possible; Marches parallel to main body and resists to allow main body to pass threatened point, joining rear guard later; must keep in communication with the column; Field trains usually join those of the main body.

OUTPOSTS:—Size, 1/20 to 1/3 entire force. **Regular Outpost** consists of Outguards, Supports, and Reserves. **Outguards** occupy line of observation and are classified as pickets, sentry squads, and cossack posts. **Supports** occupy line of resistance; size, from ½ company to 1 battalion, they furnish the outguards and reliefs for same. Numbered consecutively from right to left; generally placed on or near a road. A support of 1 battalion covers with its outguards a sector rarely exceeding 2,500 yds. **Reserves** may be omitted when outpost consists of less than 2 companies; **size** from ¼ to 2/3 entire outpost; centrally located; only part of outpost that is allowed to have fires; Outpost Commander with the reserve. **Pickets** consist of from 2 squads to ½ company; furnish sentinels, double sentinels, sentry squads, or cossack posts; placed at road forks, etc.; numbered consecutively from right to left in each support. **Sentry Squads;** usually composed of 1 squad (8 men) each; posts 1 double sentry. **Cossack Posts;** composed of 4 men; posts 1 sentinel. **March Outpost;** made up of the nearest troops available at the end of a march, being usually that day's advance guard. Is replaced by regular outpost as soon as possible. **Outpost Order:**—Issued on receipt of halt order after estimating the situation (See forms for field orders). Contents; Line of resistance to be held; tactical divisions of outposts and sectors or duties assigned to each; disposition of reserve and instructions for Cavalry. Distribution of troops, giving composition and location of Advance Cavalry, supports, detached posts, reserves. **Second Outpost Order:**—Issued if Outpost Commander deems extensive changes necessary after inspection of outpost positions.

PATROLS

General Rules regarding:—Size, from 2 men to 1 company. Send out patrol for one definite purpose and one only. Send out only such patrols as will effect desired ends. Besides arms and ammunition, patrol leader should have (a) compass, (b) watch, (c) pencil, (d) notebook, (e) field message blanks, (f) map of country, (g) field glass. Officers sending out patrols should verify details, make inspections, designate a second in command, and give such instructions as may be necessary. Important or comprehensive instructions should be in writing. Patrol leaders and men should be selected with care. Formation of patrols should favor the escape of at least one man. Number of signals and reports should be understood. See also page 45.

Relay Posts:—From 5 to 10 miles apart. Strength, 1 N. C. O. and 6 Pvts. to ½ troop.

Independent Cavalry:—A brigade of 3 regiments covers a front of about 10 miles.

Troops that pass a point in 1 minute:—Infantry in column of squads 175; Cavalry in column of 4's, walk 110, trot 200, gallop 300; guns, caissons, wagons 5.

Dust Clouds:—Infantry, thick and low; Cavalry, thin and high; Artillery or wagons, broken cloud.

Signals:—Enemy in sight, few—rifle horizontal above head; many—same, but raised and lowered. Take cover—downward motion of hand. Others as agreed upon; should be few and simple.

Orientation:—**By watch:**—Point the hour hand toward the sun; half way between the hour hand and 12 o'clock (on the watch face) is SOUTH. True for any time of day. **By the "dipper":**—The two stars that form the side of the bowl of the dipper that is farthest from the handle point almost directly to the North Star, which is a prominent star about as far away from the dipper as the dipper is long.

Duties of an Officer Sending Out a Patrol

1. Verify detail. 2. Designate second in command. 3. Inspect men and animals—suitable equipment, arms, ammunition, field glasses, watches, pencil and message book, map of locality, filled canteens, no rattling or shining equipment, no animals with cough or which neigh, sobriety and freedom from illness. 4. Issue orders as follows:—

Orders for a Patrol

1. Where the enemy is. 2. What the mission of the patrol is. 3. General direction to be followed. 4. Places to visit and to avoid. 5. Where messages are to be sent. 6. Where patrol is to report and when. 7. How far to go and when to return. 8. What to do if fired upon. 9. Select a good rallying point. 10. No talking nor smoking. 11. Signals to be used. 12. Whether friendly patrols are out. (See orders for scouts.)

Contents of a Halt Order

1. Information of enemy; 2. Assigns camp sites; 3. Details the troops to constitute outpost; 4. Assigns an outpost commander; 5. Designates general line to be occupied; 6. Points out positions to be held if attacked.

Contents of an Outpost Order

1. Information of enemy; 2. Designates troops to constitute the supports, and assigns their location with sector each is to cover; 3. Provides for necessary detached posts; 4. Directs necessary reconnaissance; 5. Orders location and disposition of reserve; 6. Disposes of trains; 7. Informs subordinates where information will be sent. Examines positions nad gives verbal corrections.

Contents of a Support Commander's Order

Explain situation to subordinates; detail troops for different outguards, defining sector each is to cover; provide sentinels at post of support, and the patrols sent therefrom; direct necessary connection with other units of outpost; direct necessary intrenching.

An Outguard Commander's Order

Given verbally after reaching position. Explain situation; establish reliefs for each sentinel; detail proper patrols and relief for same, and their routes and frequency.

Orders that should be given a Sentinel

Where enemy is supposed to be; direction enemy may advance; names of villages and towns in sight; the points of the compass; where roads lead; number of his post and that of adjoining posts; location of his and other outguards; position of the support; whether or not friendly patrols are out; how to give the alarm; of what to notify his corporal; halt all persons at night with piece at ready; in day to permit persons he **knows** to pass; fire on those failing to halt; how to handle deserters and bearers of flags of truce; converse with no one; remain stationary and concealed at night except for observation; do not sit down nor lie down; carry piece loaded and locked; know the names of officers of the outpost.

Orders for Scouts (also Patrols)

1. Keep out of sight and keep quiet. 2. Report anything of value not already known that will arrive in time to be of value. 3. Give your source of information. 4. Refer to points of compass in reporting. 5. Send a sketch if time admits but do not delay information on account of sketch.

6. Don't exaggerate. 7. Tell your next plans. 8. Repair any and all breaks in our own field lines and cut those of the enemy.

Orders for Messengers

1. Where to go, when, and by what route. 2. To whom to deliver the message and what to do when he has delivered it. 3. When and by what route to return, or where to go next. 4. What speed to take. 5. Whether enemy is liable to be encountered and where. 6. What his message contains. 7. What to do if he cannot find the person to whom sent.

COMBAT PRINCIPLES

Obtain fire superiority; keep units intact; assign simple tasks; assign sufficient troops at first; avoid detachments; keep effective reserves; protect flanks; keep up reconnaissance; afford troops every opportunity to rest when possible.

Fronts for Initial Deployment

Field Army of 3 Divisions:—3 to 4 miles.
Division:—Attack, enveloping 4,000 yds., frontal 2,500 yds.; Defense, 3,600 yds.
Brigade:—Attack, enveloping 2,000 yds., frontal 1,200 yds.; Defense, 1,600 yds.
Regiment:—Attack, enveloping 1,000 yds., frontal 500 yds.; Defense, alone 600 yds., part of interior line 800 yds.
Battalion:—Attack, enveloping 500 yds., frontal 250 yds.; Defense, alone 300 yds., part of interior line 400 yds.

Reports

Remarks:—A formal, detailed, and comprehensive statement of facts accompanied by a sketch.

Form:—(a) Heading—"Report on ....."; (b) place and dates; (c) "By ....." (name and rank of officer); (d) Authority (quote order); (e) Details of report:—Left such place such time, so many officers and men; arrived such places such time, losses and gains; details regarding accomplishment of mission or reason for its failure.

For form of report concerning a march, see "Marches."

Messages

Remarks:—Brief and clear. Important messages to be sent in duplicate by two different messengers over different routes and messengers informed of contents. Verbal messages to contain but one short mandate and be repeated to sender by messenger.

Speed of delivery:—Mounted messengers, 5 miles per hr., "ordinary"; 7 miles per hr., "rapid"; as fast as possible and yet secure delivery, "urgent."

Form:—Like a telegram. Mark on envelopes or outer fold (a) name of messenger, (b) time of his departure, (c) rate of his speed, (d) person to whom message is sent.

War Diary

Note:—Submitted daily to Adjutant or next higher commander by each field unit between midnight and 10:00 a. m. Record of complete day of 24 hours. First report to give strength present and the absentees, officers and men, former by name, and cause of absence, officers who own extra mounts and are not riding same, number of Darnall fitters with command, whether officers are mentally and physically able to perform their duties. Subsequent reports to show only the changes. All reports to show, in this order: (1) Organization, (2) Place and date, (3) If on a march, From ..... **(place)** left camp ..... **(when)**; if stationary, at ..... **(place)**. (4) If on a march, To ..... **(place)** arrived ..... **(when)**; if stationary, nothing. (5) Roads, weather, shelter; (6) Supply—water (surface, quantity, boiled or filtered or neither); (7) Forage—kind, amount on hand; (8) Fuel—amount on hand; (9) Subsistence—rations on hand and kind; (10) Movement of all trains; (11) Security—means taken for; (12) Health of command; (13) Losses—personnel (names and causes), animals (number and causes), material (kind and causes); (14) Gains, if any (as for "losses"); (15) Remarks—Action to be noted, sketches of positions, location of different units, copies of orders issued or received,

or digest of same, amount of patrolling, information of enemy determined by that unit, disposition of dead and wounded, comments, recommendations; (16) Signature and rank.

FORMS

Pass:—Give place and date of issue; name of person; where he is living; what mission he is on; state that he is authorized to pass out (in) of the lines for a certain purpose (naming the purpose); state where he will cross the lines, at what time of day, dates; state what he is authorized to take with him (persons, articles, or vehicles); state his destination and the route he will take. Authentication. Photograph of person.

Safe Conduct:—Place and date of issue; name of person, residing (such place); mission, authorized to proceed to (name place) for purpose of (name purpose). Route to be followed; authorized to take with him (person, articles, vehicles) S. C. good until (date); Heavy print:—"All military authorities are directed to protect the bearer of this safe conduct and in no wise molest him." Authentication. Photograph.

Safe Guard:—Place and date of issue. All officers and enlisted men belonging to the (name Army or its subdivision) are directed to respect the premises of (name person) situated at (name place). No requisitions thereon, nor damage thereto, will be permitted, and protection will be afforded by all officers and enlisted men against any person who shall attempt to act in violation of this order. Authentication. Photograph. Quote 2 A. W. and 78th A. W.

Armistice:—Give names of agreeing officers and their superiors authorizing such agreement.

Art. 1. Hostilities to cease, between what forces, where.
Art. 2. Armistice in force from (date and hour) to (date and hour).
Art. 3. Resumption of hostilities, time, armistice expires.
Art. 4. No changes in positions of troops.
Art. 5. May strengthen positions, receive reinforcements, stores, may do any act not that of actual hostilities.
Art. 6. Burial parties.
Art. 7. Road used for communication between both armies.
Art. 8. Civilian inhabitants allowed to buy and sell, produce, etc., but not to enter lines to obtain information.
Art. 9. Armistice to take effect (when); officers to spread information to troops.

Reconnaissance Reports

Road:—Name, width, gradients, condition, ditches and drainage, paved or not, fills, cuts, defiles, bridges, fences, cross roads, how lighted, towns, camping places, farms, suitable for what troops, draw sketch.

Bridges:—Where located, kind of bridge, type of construction, width clearance, what kind of abutments, length of span, height above stream, nature of approaches, suitable for what troops, material at hand for making suitable for all troops, protected positions near, draw sketch.

Camping Places:—Location, size, suitability for troops, soil, drainage, fuel, forage, water, defensibility, shelter, communications, railroads near, cost per day, sketch.

Rivers and Streams:—Name, direction of flow, rate of flow, width, velocity, mean depth, fords and bridges and ferries, fluctuations in depth, nature of banks, navigability, boats available.

Country:—Roads, woods, soil, cultivation, population, topography, rivers and streams, fences, adaptability to attack, defense, maneuvering, camp sites, supplies, where and to what extent obtainable, character of cultivation, vegetation, timber, give general description—rolling, hilly, marshy, etc. Sketch and approximate distances to important features.

Towns:—Name, location, population, industries, railroads, water supplies, location of—R. R. station, postoffice, telephone exchange, telegraph office, city hall, blacksmith shop, fuel and forage stores, meat and grocery stores, lighting, streets, hospital, banks, accommodations for billeting troops, how defended, camp sites in or near, character of the inhabitants and the prevailing nationality.

Railroads:—Name, gauge, direction, number of tracks, telephone and telegraph lines, sidings, whether or not provided with block signals and kind, towns, bridges, tunnels, ramps, crossings, stations, construction and

condition of R. R. bed, water available, steepest gradients, amount and condition of available rolling stock, material for repairs.

Water:—Where found, amount, quality, source, fluctuations in supply, can it be cut off, danger of pollution, place for drinking, animals, and bathing.

Fords:—Exact position, approaches, nature of footing, width of ford, depth (allow Cav. 4′ 4″, Inf. 3′ 6″, F. A. and wagons 2′ 4″), defensibility, effect of traffic and weather.

Defensive Position:—Length of position—allow 3 men per yard; number of troops; nature of flank protection; natural cover for and location of supports, reserves, and trains necessitating depth of 800 to 2,400 yards; long position must be deep; natural defense—streams, fences, ditches, etc.; strong points in front of line; nature of soil for digging; drainage; artillery position; best method of attacking position; defensive position including counter stroke; supply of food and water; care of wounded and dead; means of lateral communication; location of line of resistance, line of observation.

Entraining and Detraining Points:—Imagine confusion and work out details and number of assistants to prevent it. At what intervals can trains arrive, where will they be put, and how handled; what is to become of each gun, wagon, animal, and man when detrained and what directions are necessary to ensure their going there. Begin report with a brief summary of result of reconnaissance—(a) suited or not to rapid entraining and detraining; (b) points of egress; (c) how many trains can be received at a time; (d) how long to entrain or detrain an assumed body of troops; (e) loading and unloading stores and their disposition after unloading; (f) ramps for animals. Draft (on the spot) the orders you would give to handle the situation. What is to become of waiting troops—how sheltered, fed, and watered.

An Artillery Position:—On the front side of the second or third hill back. Artillery does not always use the reverse side of a slope, but the position should be out of the sight of the enemy. Let location of Artillery be second to that of Infantry.

Road Space

Infantry in col. of squads, Cav. in col. of 4's, guns and wagons in single column. Unless specified, figures are in yards and the first figure represents the organization plus its combat trains, the second figure the organization plus combat train plus field train without distance.

Division, Inf. or Cav., 8 miles, 9.5 miles; Brigade, Inf. or Cav. 1.5 miles, Art. 2.6 miles, 3 miles.
Trains only:—Inf. Div. Amm. 2,440, supply 2,000, sanitary 1,600, Engineer 150; Cav. Div. Amm. 500, supply 1,200, sanitary 900.
Infantry:—Company 50; Battalion 200, 220; Regiment 900, 1,200.
Cavalry:—Troop 100; Squadron 400, 440; Regiment 1,900, 2,200.
Horse Artillery:—Battery 380, 440; Battalion 1,200, 1,400; Regiment, 2,500, 3,000.
Light Artillery:—Battery 300, 400; Battalion 900, 1,200; Regiment 2,000, 2,600.
Heavy Artillery:—Battery 350, 440; Battalion 1,000, 1,400; Regiment 2,500, 3,000.
Mountain Artillery:—Battery 250, 320; Battalion 750, 1,000; Regiment 1,600, 2,200.
Engineers:—Pioneer Company 150; Ponton Company, light 350, heavy 450.
Signal Troops:—Radio Company 300, battalion 600; Field, company 300, battalion 600; Telegraph company 400, battalion 800; Aero squadron 600.
Ambulance company 300; Field hospital 200.
Foot troops, 2 men per yard; mtd. troops, 1 man per yd.; each gun, caisson, or wagon, 20 yds.

Camp Space Required

Figures are square yards, first figure is for normal camp (normal tentage), second figure is for restricted camp (shelter tents).
Division, Inf. or Cav., restricted camp, 150 acres or 75,000 sq. yds., for normal space multiply by 3.

Infantry:—Company 4,700, 1,500; Battalion 20,000, 6,000; Regiment 60,000, 19,000; Brigade 200,000, 66,000.
Cavalry:—Troop 10,000, 3,500; Squadron 40,000, 13,000; Regiment 120,000, 40,000; Brigade 400,000, 120,000.
Horse Artillery:—Battery 2,500, 1,400; Battalion 75,000, 48,000; Regiment 155,000, 96,000.
Light Artillery:—Battery 20,000, 12,000; Battalion 60,000, 36,000; Regiment 121,000, 72,000.
Heavy Artillery:—Battery 22,000, 13,000; Battalion 65,000, 40,000; Regiment 130,000, 78,000.
Mountain Artillery:—Battery 8,000, 5,000; Battalion 25,000, 15,000; Regiment 50,000, 31,000.
Engineers:—Pioneer Company 7,000, 2,500; Battalion 30,000, 10,000; Regiment 100,000, 30,000. Ponton Company 20,000, 12,000; Battalion 80,000, 50,000.
Signal Troops:—Radio Company 7,000, 4,000; Battalion 15,000, 8,000; Field Company 6,000, 3,600; Battalion 12,000, 7,200; Telegraph Company 9,000, 6,000; Battalion 18,000, 12,000; Aero Squadron, 100,000, 62,000.
Ambulance Company 9,000, 6,000; Field Hospital 9,000, 7,000.
Ammunition train, Inf. Div. 51,000, 40,000; Cav. Div. 10,000, 6,000; Supply train, Inf. Div. 45,000, 38,000; Cav. Div. 27,000, 16,000; Sanitary train, Inf. Div. 36,000, 30,000; Cav. Div. 20,000, 14,000.

To reduce sq. yds. to acres multiply sq. yds. by 0.0002066, or roughly, 0.00021.

Selecting Camp Site and Establishing Camp

Conditions governing selection:—Ground to accommodate command; drainage good; no stagnant water within 500 yards; water supply sufficient, good quality and convenient; forage and fuel present or obtainable; short grass and sandy subsoil best; high and shaded in summer; south side of hill with trees to north in winter; ground near foot of hill avoid; dense foliage undesirable; accessible to road.

On establishing camp:—Designate location of units; officers' headquarters, kitchen, latrines, corral, picket line. Designate places for obtaining drinking and cooking water and water for animals and bathing and post suitable guards over same. Give orders relative to obtaining fuel and forage, restricted localities, formations and calls, and drainage of camp, also protection of same in time of hostilities.

MARCHES

Consider road space when drafting orders. Camp troops in order of march. **Estimation of road space**—foot troops 2 men per yard, mounted men 1 man per yard when marching 4 men abreast; gun, caisson, wagon 20 yards; auto trucks 12 yards. **Order of march**—Cavalry and horse artillery; infantry and light or mountain artillery; engineers and signal troops; trains. **The start:**—Foot troops not before daylight, mounted troops 1 hour after daylight. Canteens filled; camp policed; fires out; latrines covered; reserve ration issued; animals and men fed; men, wagons, and animals packed; clear points at times specified in march order, and preserve distances thus gained.

Duties of Commander:—Sees to necessary preparations; that men and animals are in fit condition and properly equipped; means for care of sick; spare parts for transportation; ample reserve supplies of all kinds; issue march order (field or routine).

March Order:—Should state: Object of march; distribution of troops; order of march; manner of forming column; the initial or starting point; hour for clearing same; routes to be followed to reach same; disposition of trains; location of commander. (See form in Field Orders.)

Rate and length of march:—Infantry—fast, 3.4 miles per hour or 100 yds. per min.; rapid, 3 miles per hr, or 88 yds. per min.; normal, 2½ miles per hour or 73 yds. per min.; miles per day, short 10, normal 15, long 20, forced 30. **Cavalry**—fast walk 4, trot 8, gallop 12 miles per hour; average, walk 1 mile in 16 minutes or 3¾ miles per hour, trot 1 mile in 8 minutes or 7½ miles per hour; average march per day 25 miles, hardened troops. **Field Artillery**—as for troops to which attached; alone can march 15 to 20 miles per day. **Wagon train**—about as for infantry, though bad roads reduce rate of train more than that of infantry. Long columns can

average only 2 miles per hour. **Pack mules**—can carry 250 lbs. 20 to 25 miles per day on good roads and 10 to 15 miles per day on trails (but load often must be reduced). **Auto trucks**—single, 8 to 20 miles per hour.

To Estimate Time for Infantry:—Multiply miles and decimals of a mile by 20, result is number of minutes for infantry to cover that distance.

Halts:—March for 45 minutes and halt for 15, thereafter march for 50 minutes and halt for 10, except that cavalry marches 55 minutes and halts 5. On long marches halt for one hour for noon meal. Halt one day in each 7 of constant marching. In hot weather marches are shorter and halts are longer. Halt troops simultaneously without closing, and begin march similarly. One minute (or, for long columns more) before halting slow rate at head of column to enable troops to close. Avoid causing troops to stand in road waiting, also avoid their marching when head of column is at halt. Short columns allow 10 yards between companies and 40 yards between battalions. Suppress drinking of water for first two hours. Serve no salty food for breakfast preceding march. Alternate the units at head of column. Send staff officer ahead to next camp. Examine and care for feet at end of march.

Journal of the march:—(a) Heading—Journal of march; organization; towns passed through and dates; name and rank of officer commanding. (b) Authority for march—Quote order. (c) Introduction—1. strength:—officers by name, enlisted men by number; medical attendance; transportation, kind and quantity. 2. Clothing:—Kind (uniform worn); additional carried in packs or train. 3. Arms and Equipment:—carried on person of soldier, on mount, additional in train. 4. Rations:—Kind and quality; where carried. (d) Details of March by Days:—(each day) Left such place, such date, such time. Number officers and men. Arrived such place such time. Number officers and men. Time of arrival wagon transportation. Number of miles march, and actual marching time. Weather conditions; condition of roads; sickness on march. Kind of camp pitched; where; remarks on the site (size, suitability, fuel, forage, water); prices, (e) Remarks and Recommendations:—(very brief) Clothing; equipment; rations; condition of command; attitude of inhabitants; sickness or epidemics in vicinity of route. Note:—In general the Journal of the March in addition to historical data, gives only such information as affects marching efficiency of command, and leaves to the Field Notes and Route Map the details of terrain.

Field Notes:—Placed on margin of Route Map when space permits, otherwise on letter paper. The purpose of these notes is to give such data as would be incorporated in the map were time and facilities available, and in addition appropriate remarks concerning: (a) Character and size of available camp grounds. (b) Practicability of all roads for different arms. (c) Location of food supplies, for men and animals, whether growing or stored. (d) Portable water for men and animals; fuel. (e) Draft and riding animals and wheeled transportation along the route.

Route Map:—Made in sections, each section containing one day's march and marked accordingly, sections folded to approximate size of letter paper (8 x 10½). Lettering (except names of roads, streams, R. R.'s) placed so as to be read facing north. North-and-South Line placed on each section. Usually no room for field notes on margin of map.

Reports on a March:—A Journal of March, Field Notes, and a Route Map are usually required for each march. They are submitted together, without letter of transmittal, to authority ordering march.

Wagon Convoys

Marching:—One convoy not more than 100 wagons, which would occupy 1 mile road space. Divide train into sections of 20 or 30 wagons each with 1 noncommissioned officer in charge of each. Distance between sections 25 yds.; distance between wagons 2 yds.; rate of march 2 to 2½ miles per hour including halts; avoid long halts; place slowest teams in lead; halt on right side of road; have rope handy and assist teams by hand when necessary. Guarded by military police, with advance guard, main body, rear guard, and flankers, and advance cavalry.

Parking:—Enemy distant, (a) column of sections or half sections, 20 yards between subdivisions, 7 yards between wagons; (b) wagons axle to axle, animals tied to picket line in front. Enemy present, (a) wagons in two lines facing each other; (b) form a square or circle, poles and

animals and men inside. Emergency, Diamond shaped corral.

Prisoners:—10 foot-soldiers and 4 mounted men per 100 prisoners; prisoners formed into companies, officers march separately. Ordered to lie down if attacked.

FIELD RANGE

Field Range No. 1, for 50 men or more:—1 body No. 41; 1 boiling plate No. 42; 1 piece 42a and 1 42b alamo attachment; 6 boilers, Nos. 48, 49, 50, 51, 53, 54; 1 cleaver, 6-inch; 1 dipper, ½ gallon, No. 55; 1 dipper, quart, No. 56; 2 forks, small; 1 grinder, meat; 1 guard, tent, 6½-inch; 3 knives, butcher, 8-inch; 2 lanterns, folding; 2 pans, bake, No. 52; 1 pipe, smoke, elbow, No. 47; 4 pipe, smoke, joints, Nos. 43, 44, 45, and 46; 4 rests, pan, No. 57; 1 saw, meat, 15-inch blade; 1 skimmer, large; 2 spoons, large; 1 steel, butcher's, 10-inch.

Field Range No. 2, for fewer than 50 men:—1 body No. 61, and 1 boiling plate, No. 62; 2 boilers, Nos. 50 and 51; 1 dipper, ½ gallon, No. 55; 2 forks, meat, small; 1 guard, tent; 2 knives, butcher, 8-inch; 1 lantern, folding; 2 pans, bake, No. 52; 1 pipe, smoke, elbow, No. 67; 4 pipe, smoke, joints, Nos. 63, 64, 65, and 66; 2 rests, pan, No. 57; 1 saw, meat, 15-inch blade; 1 skimmer, small; 2 spoons, small; 1 steel, butcher's, 10-inch.

To install field range in a baggage car:—Construct a box 6′ 8″ long by 24½″ wide and 12″ deep, inside measurements. Line sides, ends, and top edge of box with galvanized iron or zinc. Place box in car running lengthwise on one side of the car, about 2 feet from the side. Fill box with dirt to about 2″ of the top. Place a brick flush with top of dirt at each of the four corners where the range will set. Place range in box, front and oven end close up against end of box, and deep enough in box so that when oven door is opened it will lie flat on edge of box. Place boiling plate in box, end resting on top of angle iron on rear of range. Place a brick under each front corner of boiling plate, flush with top of dirt. Alamo attachment is not used.

Fasten range and boiling plate firmly to box by means of wire. Fill space between range, boiling plate, and side of box with soft mud to prevent heat from escaping. Three or four field ranges may be installed in a car.

Remove one of the top ventilating windows from car; tack tent guards, furnished with each range, over the opening—one on the outside of the car and one on the inside. Carry stovepipe up and out through the opening. End of pipe should extend about 6 inches outside of the ventilator opening. Elbow should be placed on end of pipe facing up, and wired firmly to car. Wire stovepipe firmly to both sides of car.

Nail 2 by 4 inch strips around sides and ends of box and to floor of car.

Additional equipment needed:—2 water cans, G. I.; 2 buckets, G. I.; 1 elbow, stovepipe; 100 ft. wire.

THE FIELD WAGON

One field wagon consists of:—Running gear; wagon body; 1 tongue; 1 doubletree; 1 lead bar; 4 singletrees; 6 bows; 2 chains, lock; 1 wagon cover; 1 jockey box and 1 oscillating box, each with padlock and keys; 1 driver's seat; 1 axle wrench. Extra:—Contents of oscillating box; also 1 reach; 1 tongue; 1 doubletree; 1 whip.

Oscillating Box, contents of:—2 brake blocks; 1 king bolt; tire bolts 1 (¼″ x 2¾″), 5 (¼″ x 3″); wagon bolts, 2 (¼″ x 1½″), 2 (5/16″ x 1¾″), 1 (5/16″ x 2″), 2 (5/16″ x 2½″), 2 (⅜″ x 3″), 1 (½″ x 11″). 4 (⅝″ x 4″); 3 links, open; 2 nuts, axle; rivets, iron, 6 (3/16″ x 1½″), 4 (¼″ x 1½″); 1 singletree; 1 axe and helve; 4 nosebags; 1 horse brush; 1 bucket, G. I.; 1 curry comb; 1 lantern complete; 4 lbs. axle grease; 4 halters and straps; 1 lantern frame combination; 1 pick axe and helve; 150 ft. ⅜″ rope; 1 spade; 1 monkey wrench; 1 ball twine; 1 blanket per mule if necessary; 2 clips, trace; 2 hames; 3 straps, hame; 36 lbs. reserve grain ration; 2 reserve rations; ½ gal. neatsfoot oil; 1 lb. harness soap; 1 sponge.

Jockey Box, contents of:—Buckles, one each of ¾, ⅞, 1, 2 inch; Rings, one each of ¾, 1, 1½, 2 inch; Snaps, one each of 1, 1¼, 2 inch; 1 spool stove wire; 128 horse shoe nails (1 lb.); 16 mule shoes, fitted.

Weights and net loads:—First value is average weight and second is maximum net load. Field wagon—1,500, 3,000 lbs.; Ambulance—1,450, 20 men; Ponton tool—1,700, 2,100 lbs.; Engineer tool—2,400, 2,500 lbs.; Bridge train, light—1,750, 1,850-2,050 lbs; Bridge train, heavy—1,750-2,200, 2,280-2,900; Signal corps lance truck—2,000 lbs., carries 300 lance poles, total weight 5,000 lbs. Average net cargo for field wagon is 2,765 lbs.

On one wagon of train carry 1 chisel, cold; 1 clinch cutter; 1 file, 12″ flat, bastard; 1 hammer, shoeing; 1 knife, farrier's; 1 nippers, pr.; 1 pinchers; 1 revolving punch; 1 monkey wrench.

Additional articles for a regimental wagon train:—2 front hounds; 2 rear hounds; 1 front wheel; 3 rear wheels; 4 stretchers; 4 log chains; 3 fifth chains; 3 wagon jacks; 1 screw jack; 1 chain wrench; 3 stilson wrenches. These should be proportioned equally throughout the train.

Dimensions relative to field wagon:—Weight, 1,500 lbs.; length of body, 9′ 6″; length from end of pole to tail gate, 21′; width of body, 3′ 3½″; depth of body, 21″ to 24″; height of bows above body, 4′ 8″ to 5′ 10″; capacity of body, 56 to 70 cu. ft.; total capacity of wagon, 125 to 150 cu. ft.; distance between outside rims of hubs, 6′ 2″; width of track, 5′ 5″; vertical clearance (with bows), 10′ 6″; horizontal clearance, 7′ 6″; normal load, 3,000 lbs.

One field wagon will hold:—600 garrison, or 750 field; or 1,200 reserve rations; or 40 sacks oats, 2 bu. each; or 46 wall tents and flies; or 92 common tents; or 10 storage tents; or 12 hospital tents; or 30 bales hay; or ⅞ cord cord-wood; or 30 boxes s. a. ammunition; or 50 surplus kits; or 250 field rolls (enl. men); or 20 officers' bed rolls; or 30 officers' field boxes; or 30 trunk lockers; or 200 cots, G. M.; or 150 tripods, iron; or 12 field ranges; or 18 pyramidal tents; or 4 ward tents (hospital); or 18 boxes tent pins, small; or 12 boxes tent pins, large; or 390 poles, upright, wall; or 375 poles, ridge, wall; or 94 poles, upright, hospital; or 65 poles, ridge, hospital; or 860 poles, upright, common; or 540 poles, ridge, common; or 325 poles, pyramidal.

A company wagon will carry 4 days' rations and forage and normal campaign allowance of tentage, baggage, and cooking utensils.

A wagon bed 10 ft. long by 3 ft. wide holds 2 bushels of grain per inch of depth. The grain capacity of any wagon in bushels = cubic feet capacity × 0.8 (close approximation).

One Ambulance consists of:—1 ambulance; 1 tool box; 2 water tanks; 2 candle lamps; 1 doubletree; 2 singletrees; 4 inside seats; 2 litters; 1 monkey wrench; 1 extra kingbolt; 2 extra axle nuts (1 each of right and left hand threads); 1 brake.

INFANTRY FIELD TRAINS

COMPANY FIELD EQUIPMENT. On combat wagon:—120 rounds rifle ball amm. for each man so armed; 21 rounds pistol amm. for each man so armed; 4 axes; 4 picks; 4 shovels; 1 litter (unless furnished battalion as a unit). **On baggage wagon:**—1 field desk (not over 30 lbs.); 1 cake turner; 1 cleaver, meat; 1 flour sieve; 1 fork, meat, large; 1 knife, butcher; 1 ladle, soup; 1 fire irons (20 lbs.); 1 camp kettle (8 lbs.) for each 25 men; 1 pan, bake, large (8½ lbs.) for each 25 men; 1 pan, dish (3.8 lbs.) for each 50 men. Total weight of mess and cooking equipment not to exceed 1 lb. per man, but may be 50 lbs. in any case.

BATTALION EQUIPMENT. Baggage wagon:—1 wagon for 4 companies; contents—officers' rolls, mess and cooking equip. for 4 companies; 1 field desk per co.; 1 tent for bn. comdr. **Ration wagons:**—2 wagons for bn.; contents—2 days' field and 1 day's reserve rations for bn.; 2 days' grain ration per animal of bn. **Combat wagon:**—1 wagon per bn.; contents—16 axes; 16 picks; 16 shovels; 2 pack saddles; 7 litters; ammunition. Note:—Each field wagon carries 1 day's grain ration per animal of that wagon.

Loading Wagons on Cars

If wagons must be knocked down:—Remove beds from running gears, take off rear-end gates. Use a 36-ft. flat car or longer. Place first bed in one corner of car, its length parallel to car so its side will come out to the stakes on side of car. Reverse second bed so its front end will be opposite rear end of first wagon, turn it bottom up, and place it partly inside and partly outside of first bed; fill this "box" with the running gear of both wagons. In this way place 12 beds in first layer of car.

Similarly for other layers. 36 to 48 beds on each car. Replace all nuts. Wire, strap, and nail wagons in place.

Loading Ambulances on Cars

If ambulances must be knocked down:—As described for wagons, except only one layer of 6 ambulances to a car. Take off rear steps.

Loading Animals in Cars

Examine cars for nails and broken boards. Have no hay or straw in car, but put sand on floor. Do not tie animals in car. Fill from ends towards center, worst animals at the ends. Alternate heads and tails. Water twice a day. Unload once in 3 days for exercise.

Pack Transportation

The height of a pack mule should be between 14.1 and 15 hands. He should weigh 950 to 1,025 lbs. He should be between 4 and 6 years old when purchased.

Loads:—250 lbs. 20 to 25 miles per day at rate of from 4½ to 5 miles per hour. Forced marches, reduce load to 200 lbs. Mountainous country, reduce load to 200 lbs. and distance to 15 miles per day. Very short marches, load may be increased to 350 lbs. With the small "Mexican" or "South American" mule reduce load to 150 lbs. Weight of average rigging (Aparejo complete) is 90 lbs.

ANIMALS

HORSES. **Saddle:**—Height between 15 and 15¾ hands; weight between 950 and 1,100 lbs.; age, 5 to 8 years.

Draft:—Height 15½ to 16 hands; weight 1,150 to 1,400 lbs.; age, 5 to 8 years.

Normal pulse of healthy horse 34 to 38, temperature 99°F.

MULES. **Draft:**—Height, wheel, 15¾ to 16¼ hands, lead, 15¼ to 15¾ hands; weight, wheel, 1,150 to 1,250 lbs., lead, 1,050 to 1,150 lbs.; age, 3 to 7 years when purchased.

Pack:—See "Pack Transportation."

CARE OF. **Water** ordinarily twice a day, hot weather, three times, before feeding or not till 2 hours thereafter. At end of march let animal rest ½ hour to hour before watering, and never water when he is hot unless march is to be resumed.

Feed:—Usually at 5:30 a. m., 11:30 a. m., and 4:30 p. m. Feed 2 ounces salt per week, per animal. A temperature of 103° indicates a sick animal.

HARNESS

What constitutes a 4-mule set of harness.

Wheel team harness:—2 back straps; 4 back strap tugs; 2 belly bands; 2 breast straps; 2 breeching bands; 2 breeching straps; 2 bridles complete; 2 choke straps; 2 collars, hair; 2 cruppers, 5 feet; 2 pair hames; 4 hame straps; 4 hip straps; 1 lines, double, 30′ pairs; 2 neck chains; 2 neck straps; 2 reins, long, 4′ 6″, pair; 2 reins, short, 2′, pairs; 2 rein straps, 8″; 4 side straps; 4 traces, 5′ 6″; also 1 whipstock.

Lead team harness:—Same as for wheel team except, 2 bridles complete without rein rings and straps; 2 carrying straps; 6′; 2 cruppers, 5′ 6″; 2 lines, double, 54′, pairs; 2 martingales.

Bridle complete:—1 bit; 2 bit straps; 2 blinds; 2 blinds, stays for; 2 cheek pieces; 1 crown piece; 1 face piece; 1 front piece; 1 throat strap;

Note:—"4-mule ambulance and wagon harness" has traces which are of leather to the breeching, with chain extensions; "ambulance harness" has all leather traces.

Spare parts for 100 sets harness in the field.

6 bits; 60 buckles, roller, asstd.; 12 chains, trace; 12 buckles, trace; 6 clips, hame; 1 pint ink, edge; 2 gallons harness dressing; 6 hames, hook, pair, high top; ¼ lb. lamp black; 3 sides leather, bridle; 1 side leather, lace; 6 sides leather, harness.

RAIL TRANSPORTATION

Capacity of standard R. R. cars.

Standard Pullman Sleepers, 14 and 16 sections, 42 and 48 men; Tourist Sleepers, 12, 14, and 16 sections, 36, 42, and 48 men; Day Coaches, 42 to 45 men (3 men to 2 seats); Stock Car, Palace or Ordinary, 16 to 20 head; Stock Car, Improved, 20 to 24 head; Stock Cars, capacity, 40,000 to 80,000 lbs.; Box Cars, 40,000 to 80,000 lbs. capacity; Flat Cars, 50,000 to 100,000 lbs. capacity.

3 Field Wagons can be loaded on 1 flat car, or 10 Field Wagons (knocked down) can be loaded on one freight and one flat car. 1 Box Car will carry 8,226 garrison, or 9,818 travel, or 13,428 reserve rations. A standard box car will contain 1,800 cubic feet.

Loading property on cars.

Property is loaded in the following order:—1. Company property. 2. Officers' baggage. 3. Enlisted men's baggage. 4. Ammunition. 5. Rations. 6. Hospital stores. 7. Tentage. 8. Cooking utensils. 9. Guns and carriages and pontons. 10. Wagons. 11. Ambulances. 12. Forage. 13. Checkable baggage of Officers and Men and Travel Rations, in baggage cars. 14. Horses and Mules.

Time required to load one train.

Infantry, 1 hour; Cavalry and Light Artillery, 2 hours; Heavy Artillery and Bridge Train, 3 hours.

Order in which trains are made up.

1. Flat cars, containing guns, carriages, pontons, wagons, etc. 2. Box cars, containing property. 3. Stock cars, containing animals. 4. Box car, containing forage. 5. Baggage cars, the last one containing travel rations, has open end to the rear—or, last one is kitchen car. 6. Passenger coaches or Tourist sleepers. 7. Standard sleepers.

What kind of cars to use.

Officers, Standard Pullman sleepers; Enlisted men, Tourist sleepers; Animals, stock cars; Guns, carriages, wagons, pontons, ambulances, flat cars; Property, forage, box cars; Baggage, travel rations, baggage cars.

THE RATION

One ration is quantity of food for 1 man for 1 day.

Approximate weight of ration:—Garrison, 4.5 lbs.; reserve, 2 lbs.; field, 3 lbs. **Carried, on each man**—2 days' reserve rations and unconsumed portion of that day's ration; in ration section field train, 2 days' field and 1 day's reserve ration per man; in supply train, 2 days' field ration (Infy.) or 1 day's field ration (Cav.) per man. Rolling kitchens, when used, 1 day's field ration per man but reduced accordingly in other vehicles. Reserve rations are consumed only in necessity when no other rations are available and only on order of superior commander. One reserve ration is bacon 12 ozs.; hard bread 16 ozs.; coffee (R. & G.) 1.12 ozs.; sugar 2.4 ozs.; salt 0.16 oz.

Allow the following for amount of food that one man will consume for one meal:—Sugar 1 oz.; coffee 0.5 oz.; chocolate or cocoa 1 oz.; tea 0.1 oz.; dried vegetables 4 ozs.; flour 4 ozs.; hard bread 4 large or 6 small; fresh vegetables 8 ozs.; bacon 4 ozs.; fresh meat without bone 7 ozs.; fresh meat including bone 12 ozs.; salt 0.2 oz; pepper 0.02 oz.; canned meat (2-lb. can) 1/6 can.

Measuring with Ordnance tin cup:—First value is **old issue** cup and second value is **new issue**—Any liquid, ⅞ qt., ¾ qt.; flour, 1 lb., ⅞ lb.; beans, rice, peas, sugar, 1½ lbs., 1¼ lbs.; hominy, cornmeal, 1¼ lbs., 1⅛ lbs.; coffee (R. & G.), 10 ozs., 8¾ ozs.; tea, Eng. breakfast, 6 ozs., 5¼ ozs.; tea, Oolong, 7 ozs., 6⅛ ozs.; tea, Young Hyson, 10 ozs., 8¾ ozs.; salt, issue, 2 lbs, 1¾ lbs. Number of rations to a cup—coffee (R. & G.), 9 rations, 8 rations; sugar, 10 rations, 8¾ rations; salt, 200 rations, 175 rations.

The Ordnance issue spoon holds:—½ ration of coffee (R. & G.); ½ ration sugar; 10 rations salt.

Hard bread:—16 pieces large size or 25 pieces small size is a ration.

RESERVE RATION CONVERSION TABLE

Articles	Unit	1	2	3	4	5	6	7	8	9	10	50
Bacon, crate.	lb.	.75	1.5	2.25	3	3.75	4.5	5.25	6	6.75	7.5	37.5
Meats, canned ...	2 lb. can	.5	1	1.5	2	2.5	3	3.5	4	4.5	5	25
Hard bread, box	lb.	1	2	3	4	5	6	7	8	9	10	50
Hard bread, pkgs.	½ lb. pkg.	2	4	6	8	10	12	14	16	18	20	100
Coffee, R.&G.	lb.	.07	.14	.21	.28	.35	.42	.49	.56	.63	.7	3.5
Sugar	lb.	.15	.3	.45	.6	.75	.9	1.05	1.2	1.35	1.5	7.5
Salt	lb.	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1	.5
Pepper, black.	can	¼ of a can to each 50 men.										

Example:—How much bacon for 66 men?

$$66 = 50 + 10 + 6 = 37.5 + 7.5 + 4.5 = 49.5 \text{ pounds.}$$

One 40,000-lb. Box Car will hold, rations:—Garrison 8,000; field 9,000; reserve 13,000; emergency 55,000.

One field wagon will hold, rations:—Garrison 600; field 700; reserve 1,000; emergency 4,000.

One ship's ton will be, in rations:—Garrison 269; field 367; reserve 362; emergency 2,200.

Cubic feet for one ration:—Garrison 0.149; field 0.109; reserve 0.1; emergency 0.015.

One army auto truck will hold, rations:—Multiply values given for field wagon by 2 for Jeffrey "quad" or similar truck, and by 1 for Ford truck.

FUEL

Authorized for field service:—1/12 of a cord of hard wood per day for each authorized mess (see F. S. R.) and same amount for each authorized pit (Par. 1044 A. R.). A regiment in the field uses about 1½ cords of hard wood per day for cooking only, and about 3 cords per day for cooking and mess incinerators; and about 6 cords per day in winter for cooking, incinerators, and heating tents; if heating fires are burned only in evenings a saving of 2 cords per day will result.

One cord of standard oak wood has for its equivalent the following:—1¾ cords soft wood; 6,000 cu. ft. gas; 10,500 cu. ft. natural gas; 40 gal. mineral oil; 64.7 kw. hours electric current; 112 gal. crude oil; 1,700 lbs. hard (anthracite) coal; 2,000 to 2,300 lbs. soft (bituminous) coal. 1 cord soft wood = 971 lbs. hard coal.

Anthracite coal, loose:—1 cu. ft. averages 54 lbs.; 1 ton averages 37 cu. ft.; 1 long ton averages 42 cu. ft.; 1,000 kilograms average 41 cu. ft.

Bituminous coal, loose:—1 cu. ft. averages 49 lbs.; 1 ton averages 41 cu. ft.; 1 long ton averages 45.5 cu. ft.; 1,000 kilograms average 45 cu. ft.

Coke:—100 bu. coal will make 120 bu. coke; 80 lbs. coal will make 48 lbs. coke.

Wood:—2¼ lbs. dry wood = 1 lb. average quality soft coal. The fuel value of the same weight of different woods is practically the same, i. e., 1 lb. dry hickory is worth no more for fuel than 1 lb. dry pine. If wood is green or wet its fuel value falls 12% for each 10% of water in wood.

One cord, dry, weighs, in pounds:—Hickory 4,500; hard maple 4,300; white oak 3,850; beech, red oak, black oak, 3,250; poplar, chestnut, elm, 2,350; average pine 2,000.

One cord measures 8′ x 4′ x 4′. To find the number of cords in a pile:—length × breadth × height (all in feet) × 0.00781 = number of cords.

FORAGE

The forage ration for a horse is 14 lbs. of hay and 12 lbs. of oats or corn or barley; for a mule, 14 lbs. of hay and 9 lbs. of oats or corn or barley; for a horse of 1,300 lbs. or over, 17 lbs. of hay and 14 lbs. of oats. To each animal 3 lbs. of bran may be issued in lieu of that quantity

of grain. 100 lbs. of straw per month for bedding is allowed each animal in the military service, except when in the field. For each animal in the military service 0.8 ounces of salt and 0.1 of a gill of vinegar per day is allowed.

The old Ordnance tin cup holds 1 pound of oats, the new ⅞ lb., both cups to be heaping full.

A box 12 x 9 x 6 inches, inside measurements, level full, holds 6 pounds of oats, i. e., 1 feeding for 1 animal if fed twice a day.

1 cubic foot baled hay weighs about 11 pounds.

Following are suitable rations:—Oats 4 lbs.; corn 6 lbs.; linseed meal 1 lb.; hay 12 lbs.; total 23 lbs. Oats 2 lbs.; corn 8 lbs.; alfalfa 10 lbs.; total 20 lbs. Corn 6 lbs.; linseed meal 1 lb.; bran 3 lbs.; hay 14 lbs.; total 24 lbs.

On a march grain only is carried. Transportation allowance for forage is 12 lbs. grain per horse and 9 lbs. grain per mule. Carried in Campaign—on each vehicle, 1 day's grain ration per draft animal of that vehicle; on each mount, the unconsumed portion of that day's ration; in ration section of field train, 2 days' grain ration per animal; in supply train, 2 days' grain ration per animal for infantry divisions, or 1 day's grain ration per animal for cavalry divisions.

Forage ration equivalents:—1 lb. grain = 1½ lbs. hay = 2 lbs. straw.

One 40,000 lb. box car will hold, forage rations:—Oats, or barley, or shelled corn, horse 3,333, mule 4,444; bran, horse 2,500, mule 3,333; hay 1,571.

One field wagon will hold, forage rations:—Oats, or barley, or shelled corn, horse 250, mule 333; bran, horse 200, mule 250; hay 175.

One ship's ton will be, in forage rations:—Oats, or barley, or shelled corn, horse 102.6, mule 136.75; bran, horse 55.5, mule 74.07.

Cubic feet for one forage ration:—Oats, horse 0.39, mule 0.293; barley, horse 0.312, mule 0.234; corn, shelled, horse 0.27, mule 0.203; bran, horse 0.72, mule 0.54; hay "oversea bales" 1.12.

One army truck will hold, forage rations:—Ford truck about same as one field wagon; Jeffery Quad (or similar truck) about the equivalent of two field wagons.

Cubic feet to the ton:—Oats 65; barley 52; corn, shelled, 45; bran 120; hay, ordinary bales, 160; hay, "oversea bales," 82. Note:—For oversea shipments hay MUST be compressed to 82 cu. ft. to the ton. Also see "Miscellaneous Reference Data—Hay."

WATER

To Purify:—Boil 20 minutes, then pour from one vessel to another. Dissolve one teaspoonful of chloride of lime in 4 ordnance cups of water; then ½ a teaspoonful of this mixture in 1 gal. of water will protect against typhoid fever or dysentery germs. If enough permanganate of potash to give a slight pinkish color to water is dissolved in it a partial chemical purification will result if allowed to stand 12 hrs.

Amount for use:—On a march, per day per man, 1 gallon for drinking and 1 gallon for ablution; per animal, 8 gallons per day for drinking and 3 gallons per day for police purposes. In temporary camp allow 5 gals. per man per day for all purposes. In permanent camp allow 30 gals. per man per day and 15 gallons per animal per day for all purposes.

Estimation of Quantity:—Average width of stream × average depth × average velocity (all in feet) × 10,800 = gallons in 24 hours.

Computations:—Head in feet = 2.30677 × pressure in lbs. per sq. inch.
= 0.01602 × pressure in lbs. per sq. foot.

Pressure in lbs. per sq. inch = 0.4335 × head in feet.

Pressure in lbs. per sq. foot = 62.425 × head in feet.

Total pressure in lbs. = 31.2125 × square of depth in feet.

Discharge in U. S. gallons per 24 hours = 538,454 × discharge in cubic feet per second.

One 4-inch (diameter) pipe, with 20 faucets, supplied sufficient water for 5,000 troops (no animals). Water head was 100 feet.

Water:—

1 Imperial Gal.	=	10 lbs.
1 U. S. Gal.	=	8.33 lbs.
1 U. S. Gal.	=	231 Cu. Inches.
1 Cu. Inch	=	0.03607 lbs. Avoir.
1 Cu. Inch	=	0.003607 Imp. Gals.

1 Cu. Inch	=	0.004329 U. S. Gals.
1 Cu. Foot	=	6.23 Imp. Gals.
1 Cu. Foot	=	7.48 U. S. Gals.
1 Cu. Foot	=	28.375 Litres.
1 Cu. Foot	=	0.0283 Cu. Meters.
1 Cu. Foot	=	62.35 lbs. Avoir.
1 Cu. Foot	=	0.557 Cwt.
1 Cu. Foot	=	0.028 Ton.
1 Pound	=	27.72 Cu. Inches.
1 Pound	=	0.10 Imp. Gals.
1 Pound	=	0.083 U. S. Gals.
1 Pound	=	0.4537 Kilo.
1 Cwt.	=	11.2 Imp. Gals.
1 Cwt.	=	13.44 U. S. Gals.
1 Cwt.	=	1.8 Cu. Feet.
1 Ton	=	35.88 Cu. Feet.
1 Ton	=	224.0 Imp. Gals.
1 Ton	=	268.8 U. S. Gals.
1 Ton	=	1000.0 Litres (approx.)
1 Ton	=	1.0 Cu. M. (approx.)
1 Litre	=	0.22 Imp. Gals.
1 Litre	=	0.264 U. S. Gals.
1 Litre	=	61.0 Cu. Inches.
1 Litre	=	0.0353 Cu. Feet.
1 Cu. Meter	=	220.0 Imp. Gals.
1 Cu. Meter	=	264.0 U. S. Gals.
1 Cu. Meter	=	1.308 Cu. Yds.
1 Cu. Meter	=	61028.0 Cu. Inches.
1 Cu. Meter	=	35.31 Cu. Feet.
1 Cu. Meter	=	1000.0 Kilos.
1 Cu. Meter	=	1.0 Ton (approx.)
1 Cu. Meter	=	1000.0 Litres.
1 Kilo	=	2.204 lbs.
1 Vedros	=	2.7 Imp. Gals.
1 Eimer	=	2.7 Imp. Gals.
1 Pood	=	3.6 Imp. Gals.
1 Russian Fath.	=	7.0 Feet.
1 Atmosphere	=	1.054 Kilos per sq. inch.

Column of water 12 inches high 1 inch diameter = 0.341 lbs.
Column 1 foot high = 0.434 lbs. pressure per sq. inch.
Column 1 meter high = 1.43 lbs. pressure per sq. inch.
Pressure of 1 lb. per sq. inch = 2.31 feet in height.

Mean atmospheric pressure = 14.7 lbs. per sq. inch and will sustain column of water 33.9 feet high.

Horse power necessary to elevate water to a given height = (weight in lbs. of water elevated per minute) × (height in feet) ÷ (33,000) + 25% for friction loss.

Capacity of cylinder in gallons = (length in inches) × (area in inches) ÷ 231.

Velocity in feet per minute, necessary to discharge given volume in given time, = (cubic feet of water) × (144) ÷ (area of pipe in inches).

To evaporate 1 cubic foot of water requires consumption of 7.5 lbs. ordinary coal, or about 1 lb. of coal to each gallon of water.

"Miner's Inch" is measure of flow of water, and is amount discharged through opening 1 inch square in a plank 2 inches thick, under a head of 6 inches to the upper edge of the opening. This is equal to about 17,000 gallons in 24 hours, or about 12 U. S. gallons per minute.

Steam:—

A cubic inch of water, evaporated under ordinary atmospheric pressure, will be converted into one cubic **foot** of steam (approximately), and it exerts a mechanical force equal to lifting 2,120 pounds one foot high.

Steam at atmospheric pressure flows into a **vacuum** at the rate of about 1,550 feet per second, and flows into the **atmosphere** at the rate of 650 feet per second.

27,222 cubic feet of steam, at atmospheric pressure, weigh one pound.

13,817 cubic feet of air weigh one pound.

Each **nominal** horse power of boilers requires about one cubic foot of feed water per hour.

Good boilers, properly set and fired, will with good draft evaporate from 7 to 10 pounds of water per hour. The average result is considerably below this.

One square foot of grate surface, under natural draft, will consume on an average from 10 to 12 pounds of hard coal, or from 18 to 20 pounds of soft coal per hour.

Under forced draft these amounts can be almost doubled.

In calculating the horse power of boilers, consider for tubular boilers, 15 square feet; for flue boilers, 12 square feet; for cylinder boilers, 10 square feet of heating surface, equivalent to one nominal horse power.

One horse power equals 30 pounds of water, evaporated into dry steam per hour from feed water at 100° Fahr., and under pressure of 70 pounds per square inch above the atmosphere.

Compound engines will develop a horse power on 15 pounds of water.

Single-condensing engines will develop a horse power on from 18 to 22 pounds of water.

Automatic non-condensing engines will develop a horse power on from 28 to 32 pounds of water.

A horse power is a power sufficient to raise 33,000 pounds one foot in one minute.

Consumption of fuel averages 7½ pounds of coal, or 15 pounds of dry pine wood for every cubic foot of water evaporated.

FLAG SIGNALING

A motion to the sender's right is a dot, and one to his left is a dash; a motion to the front is an interval.

Sample form for flag signaling when using the Signal Corps message book:—

The following message is supposed to be No. 1; to be sent from station A by CD to LM at station B; to check 26 words; to be an official message; to have been written on the 20th of the current month at 6:20 a. m. and to be the writer's 3rd message to that same address that day. - - - message is sent:—

Nr front 1 front A front CD front Ck front 26 front front fm front (followed by words on that line) at front (followed by words on that line) 20 front ho front 620 front AM front Nr front 3 double dash (wigwag) one chop-chop (semaphore) To front (followed by address) double dash (wigwag) one chop-chop (semaphore) (now the message proper followed by) front front Sig front (then the signature and) double dash (wigwag) two chop-chops (semaphore).

Receiver then checks the message and sends back:—

R front B (if his station is B) front LM (if his own signature is LM) front front front; the sending operator entering B LM in the 4th square and the time (as then shown by his watch) in the 5th square at the top of the blank.

When the message is completed the entire top line of both the sending blank and the receiving blank should have been filled in; the first time space is the time sent and the second is the time received. The words "time filed" in the upper left hand corner of the blank is the time and date that the writer gave it to the operator to send, hence the receiving blank contains nothing in this space.

In checking, check not only the body of the message, but also the address and the signature. All dictionary words, separate figures, marks of punctuation, abbreviations, names of states, cities, counties, towns, etc.—are 1 word each. Example of 1 word - - I, 2. ; , M. , New York , New York City, P.M., Example of two words - - Ohio River, 37, Mrs. D; Example, $ 82.5 - - 5 words; ¾ - - 3 words. But common practice is to spell out punctuation marks appearing in the body of a message or else omit them.

If receiver's check does not agree he sends back:—Ck (and the check as receiver makes it). If sender sees his error and agrees he returns:—Ck (followed by correct check). If sender does not agree he returns Ck (followed by original check and immediately gives the first letter of each word of his check—receiver breaks when error has been found).

Note:—At urgent speed and for distances up to about half a mile, a mounted messenger can deliver a message of 10 words in less time than the same can be delivered by wire.

Infantry:—

AM—Ammunition going forward, or required.
CCC—Charge (mandatory at all times).
CF—Cease firing.
DT—Double time or "rush."
F—Commence firing.
FB—Fix bayonets.
FL—Artillery fire is causing us losses.
G—Move forward.
HHH—Halt.
K—Negative.
LT—Left.
O—What is the (R. N., etc.)? Interrogatory. (Ardois and semaphore only.)
. . — — . . —What is the (R. N., etc.)? Interrogatory. (All methods but ardois and semaphore.)
P—Affirmative.
RN—Range.
RT—Right.
SSS—Support going forward, or needed.
SUF—Suspend firing.
T—Target.

Cavalry:—

AM—Ammunition going forward, or required.
CCC—Charge.
CF—Cease firing.
DT—Double time, rush, or hurry.
F—Commence firing.
FL—Artillery fire is causing us losses.
G—Move forward.
HHH—Halt.
K—Negative.
LT—Left.
M—Bring up the horses, or horses going forward.
O—What is the (R. N., etc.)? Interrogatory. (Ardois and semaphore only.)
. . — — . . —What is the (R. N., etc.)? Interrogatory. (All methods but ardois and semaphore.)
P—Affirmative.
R—Acknowledgment.
RN—Range.
RT—Right.
SSS—Support going froward, or needed.
SUF—Suspend firing.
T—Target.

Field Artillery:—

. . . . . —Error. (All methods but ardois and semaphore.)
A—Error. (Ardois and semaphore only.)
AD—Additional.
AKT—Draw ammunition from combat train.
AL—Draw ammunition from limbers.
AM—Ammunition going forward.
AMC—At my command.
AP—Aiming point.
B (numerals)—Battery (so many) rounds.
BS (numerals)—(Such.) Battalion station.
BL—Battery from the left.
BR—Battery from the right.
CCC—Charge (mandatory at all times). Am about to charge if not instructed to contrary.
CF—Cease firing.
CS—Close station.
CT—Change target.
D—Down.
DF—Deflection.

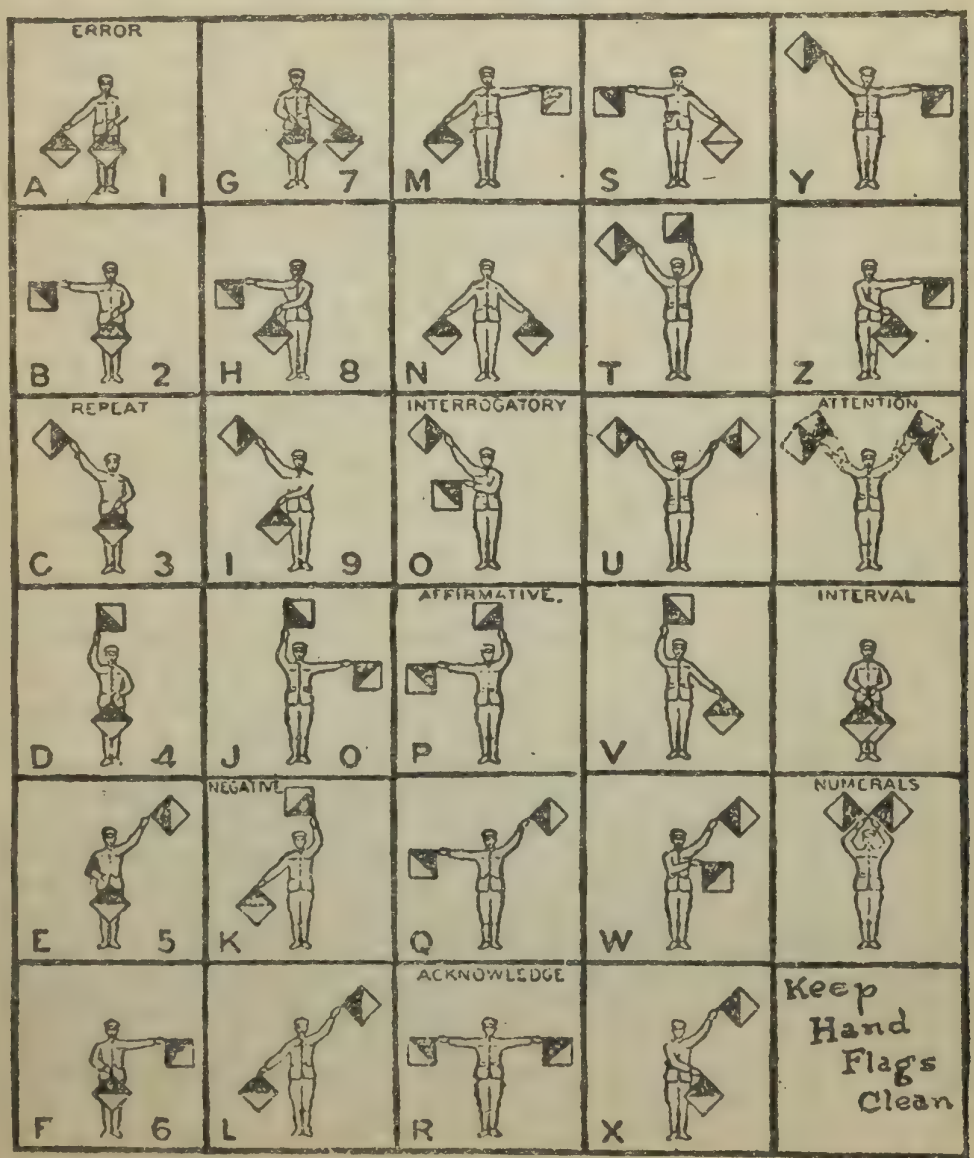
DT—Double time. Rush. Hurry.
F—Commence firing.
FCL (numerals)—On 1st piece close by (so much).
FL—Artillery fire is causing us losses.
FOP (numerals)—On 1st piece open by (so much).
G—Move forward. Preparing to move forward.
HHH—Halt. Action suspended.
IX—Execute. Go ahead. Transmit.
JI—Report firing data.
K—Negative. No.
KR—Corrector.
L—Preparatory. Attention.
LCL (numerals)—On 4th piece close by (so much).
LOP (numerals)—On 4th piece open by (so much).
LT—Left.
LL—Left from the left.
LR—Left from the right.
LE (numerals)—Less (so much).
MD—Move down.
ML—Move to your left.
MR—Move to your right.
MU—Move up.
MO (numerals)—Move (so much).
N—Annul, cancel.
O—What is the (R. N., etc.)? Interrogatory. (Ardois and semaphore only.)
. . — — . . —What is the (R. N., etc.)? Interrogatory. (All methods but ardois and semaphore.)
P—Affirmative. Yes.
PS—Percussion. Shrapnel.
QRQ—Send faster.
QRS—Send slower.
QRT—Cease sending.
R—Acknowledgment. Received.
RS—Regimental station.
RL—Right from the left.
RR—Right from the right.
RN—Range.
RT—Right.
S—Subtract.
SCL (numerals)—On 2d piece close by (so much).
SOP (numerals)—On 2d piece open by (so much).
SH—Shell.
SI—Site.
SSS—Support needed.
T—Target.
TCL (numerals)—On 3d piece close by (so much).
TOP (numerals)—On 3d piece open by (so much).
U—Up.
Y (letter)—Such battery station.

Character	American Morse	General Service
A	· —	· —
B	— · · ·	— · · ·
C	· · ·	— · — ·
D	— · ·	— · ·
E	·	·
F	· — ·	· · — ·
G	— — ·	— — ·
H	· · · ·	· · · ·
I	· ·	· ·
J	— · — ·	· — — —
K	— · —	— · —
L	— · ·	· — · ·
M	— —	— —
N	— ·	— ·
O	· · ·	— — —
P	· · · · ·	· — — ·
Q	· · — ·	— — · —
R	· — ·	· — ·
S	· · ·	· · ·
T	—	—
U	· · —	· · —
V	· · · —	· · · —
W	· — —	· — —
X	· — · ·	— · · —
Y	· · · ·	— · — —
Z	· · · ·	— — · ·
1	· — — — ·	· — — — —
2	· · — · ·	· · — — —
3	· · · — ·	· · · — —
4	· · · · —	· · · · —
5	— — —	· · · · ·
6	· · · · · ·	— · · · ·
7	— — · ·	— — · · ·
8	— · · · ·	— — — · ·
9	— · · —	— — — — ·
0	— — — —	— — — — —
and	· · · ·	
comma	· — · —	· — · — · —
period	· · — — · ·	· · · · · ·
interrogation	— · · — ·	· · — — · ·
exclamation	— — — — ·	— — · · — —
hyphen	hx	— · · · · —
shillings	ut	
underline	ux	· · — — · —
cipher	tw	
apostrophe		· — — — — ·
paragraph	— — — —	
semicolon	si	— · — · — ·
colon	ko	— — — · · ·
colon dash	ka	
dash	dx	— · · · · —
pounds	px	
dollars	sx	
parenthesis, begin	pn	— · — — · —
parenthesis, end	pq	
quotation, begin	qn	· — · · — ·
quotation, end	qj	
brackets	bx	

SIGNAL CODES—Concluded

Character	American Morse	General Service
capital	cx	
capitals	cxs	
fraction bar		— . . — .
cross		. — . — .
double dash		— . . . —
attention	— . . —	— — — — .
distress		S O S
call		— . — . —
decimal (7.4)	7 dot 4	
fraction (¾)	3 e 4	
error	bk	. . . . .

TWO-ARM SEMAPHORE CODE



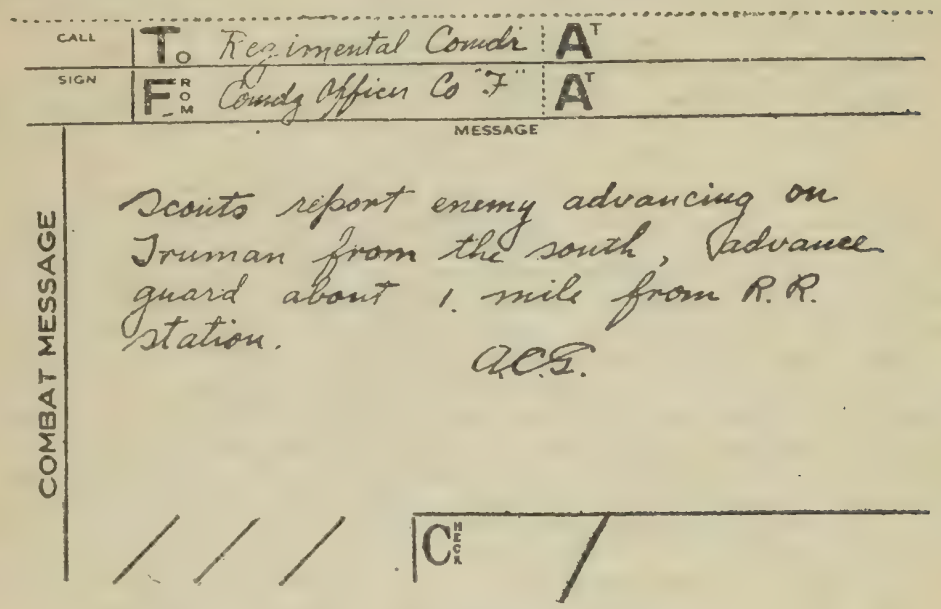
Conventional Signals and Instructions (Two-Arm Semaphore Code)

To call or answer: "Attention" followed by call letter of station called. Repeat as necessary.
Both stations then make "Interval."
Repeat last word: CC "Interval" twice.
Repeat last message: CCC "Interval" three times.
Repeat after (word): CC "Interval" A (word).
End of word: "Interval."

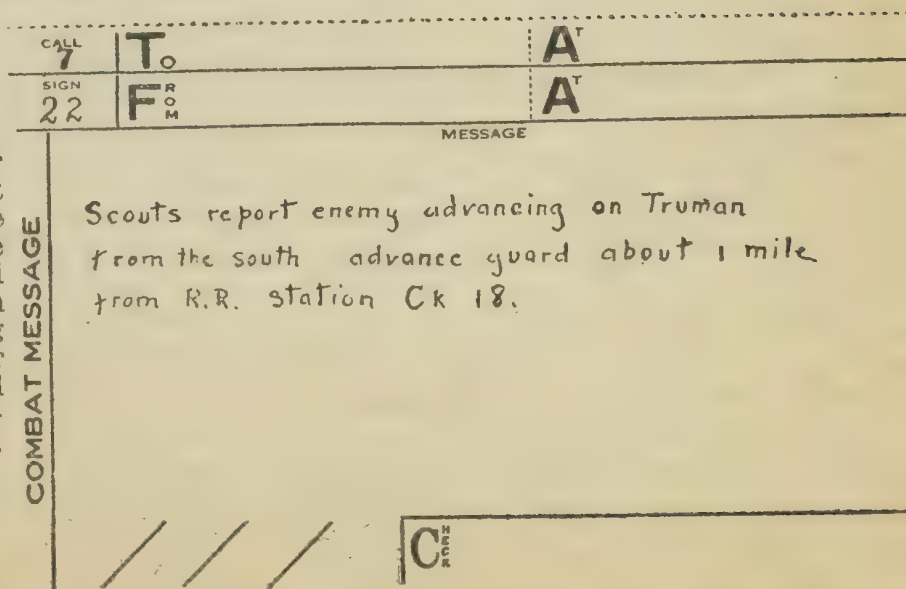
End of sentence: "Chop-chop" signal (made by placing both arms at the right horizontal and moving them up and down in a cutting motion).
End of message: Two successive "chop-chop" signals and withdrawing flags from view.
Error: AA "Interval," then repeat word.
To break in: "Attention."
Acknowledgment or understood: R
"Negative," "Affirmative," or "Interrogatory," followed by "Interval," give corresponding meanings to the following signal.
Receiver acknowledges "Attention" whenever made, also "Repeat," etc., and "End of message," when latter is understood.
While waiting for "Acknowledgment," or in case of delay, remain at "Interval."
Words not in code are spelled out.
"Numerals" precedes every number sent and indicates numerals until "Interval" is made, after which letters recur without any further indication. When numerals follow letters no intervening "Interval" is necessary. The numerals are the first ten letters in order.
When communicating with the Navy, numerals will be spelled out.

THE GUILD COMBAT MESSAGE

What the WRITER writes



What the SENDER sends



Note:—If the signalists are familiar with the Guild list of abbreviations the message would be sent "Scts rprt nmi advg on Truman fm t so (2 fronts) Ag abt 1 mi fm Rr station Ck 18." and a saving of 34 characters would result.

What the RECEIVER delivers to the recipient

CALL 7	To C.O. 21st Inf	At Crossroads
SIGN 22	From C.O. Co. F 21st Inf	At Hill 107

COMBAT MESSAGE

MESSAGE

Scouts report enemy advancing on Truman from the south advance guard about 1 mile from R.R. station.

8/23/16/8 10 a.m. | Check ||||| ||||| ||||| III — 18

USE OF THE GUILD COMBAT MESSAGE

This is the type of message which forms the pad in the back of the book. For complete explanation see "Flag Signalists' Handbook"—Guild.

This form may be used for any message sent by any means, but is most useful with the flag to reduce time necessary for transmission. THE WRITER writes the message out in full, entering the person to whom sent and his location and signs his initials. THE SENDER sends neither the address, from whom sent, nor locations provided the writer is an organization commander and the recipient is also, otherwise the writer and recipient are named. Locations are omitted when they are those of the sending and receiving signalists, otherwise they are sent. THE RECEIVER identifies the recipient by the CALL that has been used, and the writer by the SIGN, and fully enters these commanders in the spaces provided; he also enters their locations as he knows them to be. The check is usually not sent, but if sent comes last, a tally being made for each word as it occurs. THE DELIVERED message must be fully made out, containing all the identifying features.

Example:—

WRITER WRITES.....(TO) C. O. 2nd Bn. (AT) Hill 102.
(FROM) C. O. Co. G. (AT) Crossroads.
Bty. unlimbering near R. R. Station.
A. B. S.

SENDER SENDS.....(CALL) 2 (front) 2 (front) 2 (front front).
(SIGN) 23 (front front front).
Bty. unlimbering near R. R. Station Ck 6.

RECEIVER DELIVERS.....(TO) Comdg. Officer 2nd Bn. 18th Inf.
(AT) Hill 102.
(FROM) Comdg. Officer Co. G 18th Inf.
(AT) Crossroads near pumping station.
Battery unlimbering near R. R. Station.

Calls and Signs for use with Guild Combat Message

These calls refer not only to the signalist who is to receive the message and the signs to the signalist who sends it, but to the COMMANDING OFFICER of the unit which the call designates. The call of any organization or commander is the same as such organization or commander's sign. Example:—The call 23 means "for the C. O. Co. G" and the sign 23 means "from the C. O. Co. G."

9.....Division, Comdr. or Hdqrs.
8.....Brigade, Comdr. or Hdqrs.
7.....Regiment, Comdr. or Hdqrs.
6.....Field Train.
5.....Machine Gun Organization.

4.....ALL TROOPS within sight under command of person signing.
0.....(Zero). Any unknown body of troops or signal station.
1.....1st Battalion or Squadron Comdr. or Hdqrs.
2.....2nd Battalion or Squadron Comdr. or Hdqrs.
3.....3rd Battalion or Squadron Comdr. or Hdqrs.

Companies, troops, and batteries. Note:—"Such battalion such company."

1st Battalion		2nd Battalion		3rd Battalion	
A	11	E	21	I	31
B	12	F	22	K	32
C	13	G	23	L	33
D	14	H	24	M	34

Note:—Batteries of Artillery to use the call of Companies and Troops of like letter designation, without reference to battalion for sake of uniformity. "4" and "0" to be used only as calls.

Letter calls:—

Advance Guard...Ag	Reserve .....Rs	Battalion .....Bn
Rear Guard.....Rg	Squad .....Sd	Squadron .....Sq
Flank Guard.....Fg	Platoon .....Pn	Patrol .....Pl
Point .....Pt	Battery .....By	Outpost .....Op
Advance Party...Ap	Company .....Co	Signal Station....Ss
Support .....Sp	Troop .....Tr	Supreme Comdr...Ko

FIELD ORDERS

Before orders are issued always test to see that the whole command is accounted for.

The hour and place in heading of order is hour and place of signature. It takes one hour for a formal order to reach lower units in a brigade, and an hour and a half in a division.

Bearer of verbal order required to repeat same before starting. Verbal orders rarely contain more than one definite mandate, and should be recorded as soon as possible after issue. Verbal orders sent only in case of necessity.

Field orders may be issued verbally, by dictation, or written, preferably the latter.

In framing field orders the integrity of units is preserved when practicable. Geographical names should appear completely written or printed in Roman capitals. When spelling does not conform to pronunciation give latter in parenthesis. Designate roads by connecting two or more places on road by dashes. Always use affirmative form of expression. Be careful as to time and place of details. Do not use ambiguous terms or forms of expression. Be brief but clear. Commander accepts entire responsibility for order. Dates are written thus, 5 Jan. 14, 3-10 P.M. In naming a night use both days, as Night 5-6 Jan. 14. Clear and decisive orders are logical results of definite and sure decisions and are means of transforming decisions into effect.

To frame a suitable field order the commander must make an estimation of the situation, decide upon a definite plan of action, then draft or word the order to carry his decision into effect.

Estimate of situation:—An estimate of the situation involves a careful consideration from the Commander's viewpoint, of all the circumstances effecting the problem. In making this estimate he considers his mission as set forth in the orders or instructions under which he is acting or as deduced by him from his knowledge of the situation, all available information of the enemy relating to his strength, position, movements, probable intentions, morale, supporting troops, etc., conditions effecting his own command, relative to strength, position, supporting troops, distances to be covered, time to be used, and the terrain in so far as it affects the particular military situation.

The Commander then compares the various plans of action left open to him and decides upon the one that will best enable him to accomplish his mission. Having made this decision he drafts his necessary field orders and issues them to the commanders concerned.

Form of Field Order:—The parts of a field order are: (a) the heading, (b) the distribution of troops (in certain orders), (c) the body, (d) the ending.

The heading should contain the title or name of the issuing officer's command, the place, date, and hour of issue, and the number of the order.

The distribution of troops shows the tactical components into which a command is divided (advance guard, main body, etc.), and the troops assigned to each; the left hand margin 1/3 of the order sheet, is usually reserved for this purpose. It is generally used in a march order and in the first field order of a command newly created. In other cases it is usually more convenient to name in the body of the order the troops and the duties assigned to them.

The body of the order contains information and instructions for the command, and is arranged in numbered paragraphs as follows:

Par. 1 contains such information of the enemy and of our supporting troops as is desirable for subordinates to know.

Par. 2 contains the general plan of the Commander, or so much of it as will ensure proper co-operation of the whole command.

Par. 3 contains the detailed tactical dispositions adopted by the Commander to carry out the plan decided upon, and includes the tasks assigned to each fraction of the command. These tasks are given under letter subheads. (a), (b), (c), etc.

Par. 4 contains instructions for the sanitary troops and the trains.

Par. 5 shows where the commander can be found, where messages should be sent, and information concerning lines of information.

The ending contains the authentication of the order and how it is communicated to the command, the latter being very important.

The map referred to should be stated.

General forms for Field Orders

For an ADVANCE

Field Orders:	(Title)
[Reference to map used]	(Place)
No.	(Date and Hour)
(troops)	
(a) Independent Cavalry:	1. (Information of the enemy and our supporting troops)
(Commander)	
(troops)	
(b) Advance Guard:	2. (Plan of Commander)
(Commander)	
(troops)	
(c) Main Body, in order of march:	3. (a) (Inst. for Ind. Cav.—place and time of departure, roads or country to be covered, special mission)
(Commander)	
(d) Right (left) Flank Guard:	(b) (Inst. for Adv. Guard—place and time of departure, or dist. it is to precede main body—route—special mission)
(Commander)	
(troops)	
(e) Signal Troops:	(c) (Inst. for Main Body—dist. it is to follow adv. guard; or place and time of departure)
(Commander)	
(troops)	(d) (Inst. for Flank Guard—place and time of departure; route; special mission)
	(e) (Inst. for Signal Troops—lines of information to be established; special mission)
	(x) (Inst. for Outpost—when relieved; subsequent duties)
	4. (Inst. for Field Train—escort; dist. in rear of column; or destination when different from that of main body)

(Instructions for Sanitary, ammunition, supply, and engineer trains when necessary.)

5. (Place of Commander, or where messages may be sent.)

(Authentication)

(How and to whom issued)

Field Orders:
No. .....
[Reference to map used]
Troops
(a) Advance Cavalry:
(Commander)
(troops)
(b) Support:
(Commander)
(troops)
(c) Reserve; in order of march:
(troops)
(d) Right (left) Flank Guard:
(Commander)
(troops)

(How and to whom issued)

(Title)
(Place)
(Date and hour)

1. (Information of the enemy and of our supporting troops)
2. (Plan of Commander)
3. (a) (Inst. for Adv. Cav.—place and time of departure, roads or country to be covered, special mission)
   (b) (Inst. for Support—place and time of departure; route; special mission)
   (c) (Inst. for Reserve—dist. at which it is to follow support)
   (d) (Inst. for Flank Guard—place and time of departure; route; special mission)
4. (Inst. for Field Train—generally to join train of column)
5. (Place of Commander, or where messages may be sent; location of lines of information)

(Authentication)

For POSITIONS IN READINESS:

Field Orders
No. .....
[Reference to map used]

(Title)
(Place)
(Date and hour)

1. (Information of the enemy and of our supporting troops)
2. (Plan of Commander—to take up a position in readiness at or near—)
3. (a) Inst. for Cavalry—to reconnoiter in direction of enemy; special mission)
   (b) (Inst. for Artillery—position or place of assembly)
   (c) (Inst. for Infantry—position or place of assembly; points to be specially held; reconnaissance)
   (d) (Inst. for Engineers—position or place of assembly)
   (e) (Inst. for Signal Troops—lines of information)
4. (Inst. for Field Trains, Sanitary, Ammunition, Supply, and Engineer trains—generally to halt at designated localities in rear, ready to move in any direction)
5. (Place of Commander, or where messages may be sent)

(Authentication)

(How and to whom issued)

For DEFENSIVE POSITION:

Field Orders
No. .....
[Reference to map used]

(Title)
(Place)
(Date and hour)

1. (Information of the enemy and of our supporting troops)
2. (Plan of Commander—to take up a defensive position at or along—for the purpose of—)
3. (a) (Inst. for Artillery—position, target, intrenching, etc.)
   (b) (Inst. for fighting line—division of front into sections and assignment of troops thereto; intrenching, etc.)
   (c) (Inst. for Reserve—troops and position)
   (d) (Inst. for Cavalry—usually to cover with its main force the more exposed flank, a detachment being sent to patrol the other; reconnaissance)
   (e) (Inst. for Engineers—defensive work, clearing fields of fire, preparation of obstacles, opening roads)
   (f) (Inst. for Signal Troops—to establish lines of information)

4. (Inst. for Sanitary train; location of dressing stations and station for slightly wounded)
(Inst. for Amm. train—location of amm. distributing stations)
(Inst. for Field and Supply trains)
5. (Place of Commander, or where messages may be sent)
(Authentication)

(How and to whom issued)

For a HALT FOR THE NIGHT (Camp with outpost):

Field Orders (Title)
No. .....
(Place)
[Reference to map used] (Date and hour)

1. (Information of the enemy and our supporting troops, including indep. cavalry)
2. (Plan of Commander—to encamp or bivouac)
3. (a) (Designation of commander and troops of outpost [see note]; general line to be held; special reconnaissance; connection with other outposts if any)
(b) (Inst. for troops not detailed for outpost duty—location of camp; designation of camp commander; observation of flanks and rear when necessary; lines of information; conduct in case of attack)
4. (Inst. for Field Train—generally to join troops, though if near enemy field train of outpost troops may be held in rear)
(Inst. for Sanitary, Ammunition, Supply, and Engineer trains, when necessary)
5. (Place of Commander, or where messages may be sent)
(Authentication)

(How and to whom issued)

Note:—Where the advance guard is large the order may direct the Advance Guard Commander to establish outpost.

For an OUTPOST:

Field Orders (Title)
No. .....
(Place)
[Reference to map used] (Date and hour)

Troops

(a) Advance Cavalry:
(Commander)
(troops)

(b) Supports (numbered from right to left)

No. 1. (Commander)
(troops)

No. 2. (Commander)
(troops)

No. 3. (Commander)
(troops)

(c) Detached Post:
(Commander)
(troops)

(d) Reserve:
(Commander)
(troops)

1. (Information of the enemy and of our supporting troops)
2. (Plan of Commander—to establish outpost; approximate line of resistance)
3. (a) (Inst. for Advance Cavalry—contact with enemy; roads or country to be specially watched; special mission)
(b) (Inst. for Supports—positions they are to occupy; sections of line of resistance they are to hold; intrenching)
(c) (Inst. for Detached Post—position to be occupied; duties; amount of resistance)
(d) (Inst. for Reserve—location; observation of flanks; conduct in case of attack; duties of special troops)
4. (Inst. for Field Train if necessary)
5. (Place of Commander or where messages may be sent, location of lines of information)
(Authentication)

(How and to whom issued)

For an ATTACK:

Field Orders (Title)
No. ..... (Place)
[Reference to map used] (Date and hour)

1. (Inf. of enemy and of our supporting troops)
2. (Plan of Commander—indicating general plan of attack, usually to envelop a flank)
3. (a) (Inst. for Artillery—position, first target, generally hostile artillery)
   (b) (Inst. for Holding Attack—Commander, troops, direction, and objective)
   (c) (Inst. for Main Attack—Commander, troops, direction, and objective)
   (d) (Inst. for Reserve—Commander, troops, position)
   (e) (Inst. for Cavalry—generally to operate on one or both flanks, or to execute some special mission)
   (f) (Inst. for Engineers—any special mission)
   (g) (Inst. for Signal Troops—to establish lines of information between the Commander, the main and secondary attacks, artillery reserves, etc.)
4. (Inst. for Sanitary Train—location of Dressing Stations and stations for slightly wounded)
   (Inst. for Ammunition Train—location of amm. distributing stations)
   (Inst. for Field and Supply Trains)
5. (Place of Commander, or where messages may be sent)

(How and to whom issued) (Authentication)

For a RETREAT:

Field Orders (Title)
No. ..... (Place)
[Reference to map used] (Date and hour)

Troops

(a) Leading troops:
(Commander)
(troops)

(b) Main Body, in order of march:
(troops)

(c) Rear Guard:
(Commander)
(troops)

(d) Right (left) Flank Guard:
(Commander)
(troops)

(e) Signal Troops:
(Commander)
(troops)

1. (Information of enemy and of our supporting troops)
2. (Plan of Commander—to retire in direction— of—)
3. (a) (Inst. for leading troops—place and time of departure, route, special mission)
   (b) (Inst. for Main Body—place and time of departure, route)
   (c) (Inst. for Rear Guard—distance from the main body, or place and time of departure, special mission)
   (d) (Inst. for Flank Guard—place and time of departure; special mission)
   (e) (Inst. for Signal Troops—lines of information)
   (x) (Inst. for Outpost—when relieved; subsequent duties—usually forming the rear guard)
4. (Instructions for Field and Divisional Trains—place and time of departure, route, escort; these trains are generally some distance ahead of the column)
5. (Place of Commander, or where messages may be sent)

(How and to whom issued) (Authentication)

For REAR GUARDS:

Field Orders
No. .....
[Reference to map used]
Troops
(a) Reserve—in order of march:
(troops)
(b) Support:
(Commander)
(troops)
(c) Rear Cavalry:
(Commander)
(troops)

(d) Right (left) Flank Guard:
(Commander)
(troops)

(How and to whom issued)

(Title)
(Place)
(Date and hour)

1. (Information of the enemy and of our supporting troops)

2. (Plan of Commander—mission of Rear Guard)

3. (a) (Inst. for Reserve—place and time of departure, or approximate distance from Main Body; reconnaissance)
(b) (Inst. for Support—place and time of departure or distance from Reserve; any special reconnaissance)

(c) (Inst. for Rear Cavalry—place and time of departure; road or country to be covered; special mission)
(d) (Inst. for Flank Guard—place and time of departure; route, special mission)

4. (Inst. for Field Train, when necessary—usually to join Train of Main Body)

5. (Place of Commander, or where messages may be sent—location of lines of information)

(Authentication)

Notes on Field Orders:—

The above forms are given for convenience and uniformity in service.

No two military situations are alike, sequence in par. 3 not obligatory—according to best judgment of Commander.

Consult Road Spaces and Marches.

Advance Guard order issued pursuant to march order and troops of Advance Guard have been notified, presumably, when and where to assemble.

If duty of the Cavalry of the Support can be performed by mounted Infantry scouts, Cavalry is not detailed.

Where Advance Guard is large the order may direct Advance Guard Commander to establish outpost.

In the order for a halt for the night omit name of Camp Commander when chief exercises immediate command.

Always number Supports from the right.

For small outposts it may be unnecessary to give marginal distribution of troops.

In the above the term "secondary attack" is used for convenience only, as the vigor of an attack might be lessened if the troops knew it was merely secondary.

In war it is not always possible to issue a complete attack order disposing of an entire command. In unexpected encounters, for instance, orders issue as the situation develops.

BATTLE ORDERS

Notes Concerning:—

Battle Orders are verbal (in some cases, written) orders issued in battle and campaign.

They should not follow any set form, but should be natural expressions of the will of the commander in clear, concise sentences of emphatic and brief military language. They vary in detail and length inversely with the size of the unit to which issued.

given to the command, first, about the enemy (his strength, position, etc.), then about our own troops, beginning with the largest unit, followed by each successive subordinate unit until the information has been fully imparted to the unit for which the order is intended.

The order must account for the entire unit and give the location of its commander during the execution of the order.

Sample Battle Order:—

(From the Commander of the 1st Platoon, Company "B," 1st Battalion, 32nd Infantry, 2nd Brigade to his platoon before moving to attack.)

"The enemy is in position on the south side of Snake Creek west of Hilsboro. He has artillery in Hilsboro.

The 1st and 2nd Brigades of our Division will attack, the 3rd will be in reserve near Jones' Farm.

The Cavalry will protect our flanks; the Artillery will occupy that ridge; the regimental machine guns will eventually take a position in those woods about three fingers to the left of that white house. The nearest dressing station will be in the clump of trees on this side of that small hill.

The 1st Brigade is on our right. This regiment is the right of our brigade. The 12th Infantry is on our left.

The 1st and 2nd Battalions constitute the firing line, the 3rd Battalion the local reserve.

Companies 'A,' 'B,' and 'C,' from right to left in order named, constitute the firing line of this battalion. Company 'D' is in support.

*The fire sector of our regiment extends from that windmill at about 2:00 o'clock to a point about one finger to the left of the cross roads.

*Our battalion sector is the right half of our regimental sector.

The right of our company sector is two fingers to the left of that windmill; the left of our company sector is four fingers to the left of that windmill.

Our platoon sector is the right quarter of our company sector.

Sergeant Brown, you are next in command.

I shall be with the platoon."

*Note:—Co. and Platoon Comdrs. omit.

FIRST AID

ANIMALS:—

To purge.
Aloes 6 drams, calomel ½ dram, ginger 2 drams.

To stimulate kidneys.
Sweet spirits of niter 1 ounce, water 1 pint.

Founder powder.
Nitrate of potash 4 ounces, gentian 4 drams.

Tonic.
Gentian 2 drams, ginger 2 drams, flaxseed meal ½ dram.

Colic.
Sweet spirits of niter 1 to 2 ounces, laudanum 1 to 4 ounces, ginger 2 drams.

Liniment.
Witch hazel 2 ounces, spirits of camphor 2 ounces, laudanum 2 ounces.

Ointment.
Iodoform 1 part, cosmoline 6 parts.

Antiseptic or sterilized dressing (for external use only).
Carbolic acid 1 part, water 40 parts; or boracic acid 1 part and water 20 parts.

To dress harness and saddle galls and to harden the skin.
Alcohol 1 part, water 1 part. If skin is abraded mix white of eggs with this mixture and apply a thick coating to injured part.

Maggots or Screw worms.
Irrigate with Solution Cresol Compound. Roll paper tube, fill with calomel, and blow into wound.

Tick ointment.
Arsenic, powdered, 1 dram; sulphur, powdered, 4 ounces; larracide 3 ounces; neatsfoot oil 1 quart.

MEN:—

Use of First Aid Packet:—

Cut away the clothing, then carefully remove the wrapper and proceed as follows:

1. If there is only one wound, carefully remove the paper from one of the two packages without unfolding the compress or bandage and hold by grasping the outside rolls of bandage between the thumb and fingers.

   When ready to dress wound, open compress by pulling on the two rolls, being careful not to touch the inside of the compress with fingers or anything else. Still holding one roll of the bandage in each hand, apply the compress to the wound, then wrap the bandage around the limb or part and tie the ends together or fasten with safety pins. The second compress and bandage may be applied over the first, or it may be used for a sling if the arm is wounded or to bind both legs together if one is injured.
2. If there are two wounds opposite each other, apply to one wound a compress without unrolling the bandage, and hold it in place by the bandage of the compress used to cover the other wound.
3. If there are two wounds not opposite each other, tie a compress over each.
4. If the wound is too large to be covered by the compress, find and break the stitch holding the compress together, unfold it and apply as directed above.

   When bleeding of a limb is too profuse to be stopped by a snugly applied first aid dressing elevate limb and apply tourniquet.

To Apply Tourniquet:—

Place pad over artery, a cork or smooth stone wrapped in a rag, over this apply a bandage, handkerchief, or cravat. Insert under this a stick or bayonet in scabbard and twist until bleeding ceases.

For wound above knee place pad near groin a little to inner side of bone.

For wound below knee place pad above calf of leg under the knee.

For wound above elbow place pad near armpit.

For wound below elbow place pad on surface corresponding to palm of hand.

Fasten end of stick with bandage or belt, and in about half an hour loosen tourniquet a little, and if the bleeding does not start leave it loose.

If bone is broken apply splint—light board, bark of tree, rifle or rifle scabbard—pad splint with pieces of clothing or blanket.

Artificial Respiration (Schaefer method):—

Lay patient on his stomach, his face to one side, his arms extended beyond his head. Kneel striding patient's thighs, facing his head. Place hands, thumbs extended along fingers, so that little fingers curl over lowest rib (bare patient's back if necessary), hands as far apart as possible (near edge of patient's body). Gradually bring weight to bear on patient's ribs (but do not break them) by pressure straight from the shoulder; Count three very slowly (3 seconds), then remove pressure suddenly. Repeat 12 to 15 times per minute.

Drowning:—

Place patient face down. Stand astride of body. Clasp hands under his belly and raise to drain water from lungs. Wipe out mouth and nose. Pull tongue forward by means of a dry rag and hold it so. Then perform artificial respiration.

All clothing should be removed, body rubbed dry, and patient wrapped in a warm blanket by a second person (if present) while the first person is performing artificial respiration.

As soon as patient is able to swallow give stimulants and hot coffee or other hot liquid nourishment.

Lightning, or other electric shock:—

Artificial respiration.

Poisons and Antidotes for same:—

In all cases of poisoning aim first to empty stomach by use of stomach tube or emetics—½ ounce of mustard to a pint of tepid water, or zinc sulphate (20 grains), or in the absence of these, large draughts of tepid water followed by tickling throat with finger or feather. Then give antidote.

Acid, carbolic	Alcohol, epsom salts.
Acid, hydrochloric	Chalk, magnesia, soap, demulcent drinks, oil stimulants. Atropin. Amyl-nitrite to nose.
Acid, hydrocyanic (prussic), and the cyanides	Flush stomach with dilute solution of hydrogen peroxide, inject hypodermically 15 minims hydrogen peroxide every few minutes until improvement. Give dilute ammonia and heart stimulants. To relieve pain give morphin and atropin. Amyl-nitrite to nose.
Acid, phosphoric, nitric, oxalic, and sulphuric	Alkalies, chalk, magnesia, lime, demulcents, soap, stimulants, Atropin. Amyl-nitrite to nose.
Aconite	Digitalis, atropin, stimulants, artificial respiration, warmth, and friction.
Alcohol	Coffee, amyl-nitrite to nose, hot and cold douche.
Ammonium and its compounds	Vegetable acids (vinegar), demulcent drinks.
Arnica	Heart stimulants.
Arsenic and its compounds, including Paris Green	Ferric hydroxide with magnesium oxide, demulcent drinks, heart stimulants.
Aniline dyes, and inks	Aromatic spirits of ammonia, internally, 30 to 60 drops; whiskey or strychnin; air; artificial respiration; heat to surface.
Benzine	Artificial respiration, atropin.
Chloral hydrate	Heat to extremities, massage, strychnin, artificial respiration.
Chloroform	Air, artificial respiration, amyl-nitrite to nose, stimulants.
Coal gas, choke damp, carbonic acid	Air, oxygen, artificial respiration, ammonia, coffee, stimulants, hot and cold douche.
Cocain	Stimulants.
Copper and its salts (bluestone)	Barley water, potassium iodide 20 grains, white of egg or milk, poultices to abdomen, morphine.
Creosote	Same as carbolic acid.
Ether	Same as chloroform.
Fish, meats, poisonous (ptomaines)	Tannin, copious draughts of strong tea, stimulants, castor oil, opium to relieve pain.
Frost bite	Grate a raw potato, place gratings on affected parts.
Iodine and its compounds	Starch.
Ink	See aniline dyes.
Lead and its compounds (paint)	Epsom salts, dilute sulphuric acid, iodide of potassium to eliminate, milk, morphine, poultices to abdomen.
Lime	Vegetable acids (vinegar, lemon juice, etc.), demulcent drinks.
Mad dog bite	Wash wound with warm vinegar, dry it, pour few drops of muriatic acid in wound. Get surgeon at once. Ligature above wound, incision, cautery.
Mercury and its compounds	Albumen in some form, as raw whites of eggs, flour, milk, potassium iodide, opium.
Mushroom or poisonous fungi	Castor oil; tincture of belladonna, 20 drops by mouth every half hour; stimulants, whiskey; heat to surface.
Opium, morphine, codein, heroin, laudanum	Rousing, coffee, ammonia, amyl-nitrite to nose, strychnin, artificial respiration.
Silver and its salts	Salt and water, albumen.

Snake bites	Stop passage of poison by tight ligature or tourniquet above bite; cut wound open, if it does not bleed freely suck it; inject around wound Solution Potassium Permanganate 1 grain to 1 fluid ounce water, or insert a few permanganate crystals in wound. Loosen ligature gradually in one hour. Stimulate with ammonia, alcohol, or strychnin.
Stings of insects	Apply ammonia water or crushed onion.
Strychnin (any form; also Nux Vomica)	Flush stomach. Give 1 to 2 grains of Iodine with 5 to 10 grains of Iodide of Potash in 1 ounce of water. Strong tea. Control spasms by 30 grains of Chloral, or 1 drachm Potassium Bromide, or Chloroform inhalations.

Note:—1 teaspoon = 1 drachm = 45 drops. 8 teaspoonfuls = 1 ounce = 2 mess spoonfuls.

COMPUTATION CHARTS

The first three charts are designed to accomplish the same results as are given with tables, but with economy of space. They are sufficiently accurate for the usual field computations.

To use any of them, place the straight edge of a piece of paper perpendicular to the lines and exactly at the number in question, then read the intersection of the paper and the scale below.

1. **Square and Cube Roots Chart:**—The least reading of the Square Root scale is 0.1 up to 14.1 and 0.01 beyond; that of the Cube Root scale is 0.1 up to 3 and 0.01 beyond. Example:—Find square root and the cube root of 355—answer, 18.84+ and 7.08 respectively.

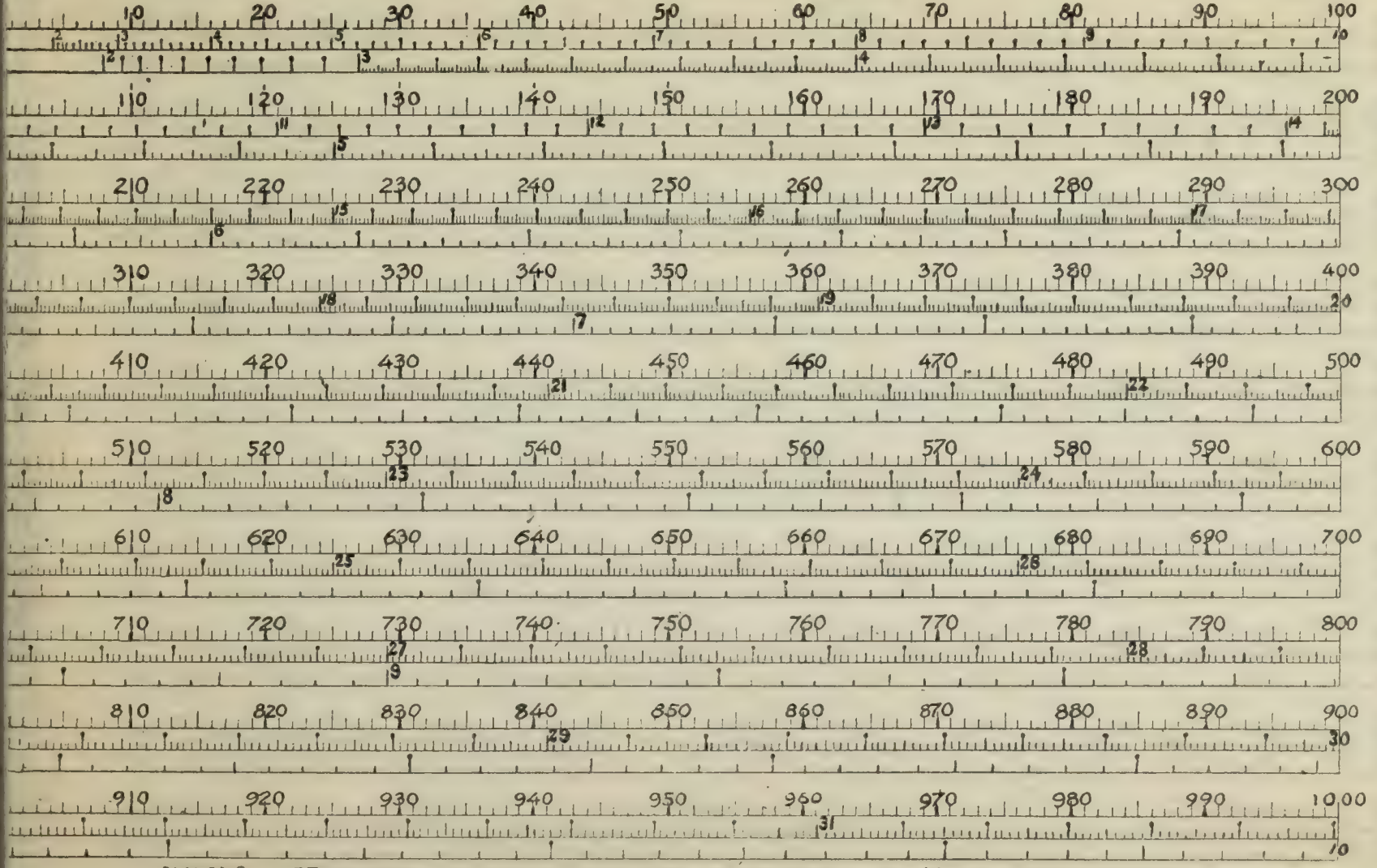
2. **Logarithms of Numbers Chart:**—Least reading of Log scale is 0.001. Example:—Find Log of 643—answer, 0.8082; also of 648—answer, 0.8116; also, what is the number whose Log is 0.5416—answer, 348.

3. **Functions of Angles Chart:**—Least reading of Sine scale is 0.0005, and of Tangent scale is 0.001. Example:—What are the Sine and Tangent of 27° 32′—answer, 0.462 and 0.521 respectively.

4. **Scales Chart:**—The TOP SCALE represents Paces on a 6 inch map for paces of different number of inches; for a 3 inch map use same scale but double the values inside the scale, which represent Paces. The SECOND SCALE is as described for top scale, substituting "minutes" for "paces." The THIRD SCALE represents Yards on a 12, 6, and 3 inch map. The FOURTH SCALE represents the subdivisions of one inch. The FIFTH SCALE represents the distance Cavalry and Field Artillery will go in a given number of minutes on a 6 inch map at a Gallop, Trot, and Walk; for a 3 inch map use same scale but double the values in minutes. The SIXTH SCALE is as explained for the fifth scale, but for Infantry at an ORDINARY and at a FAST walk. The BOTTOM THREE SCALES are for the owner to insert his own scales. At THE SIDE is a 4 inch scale and a 10 centimeter scale.

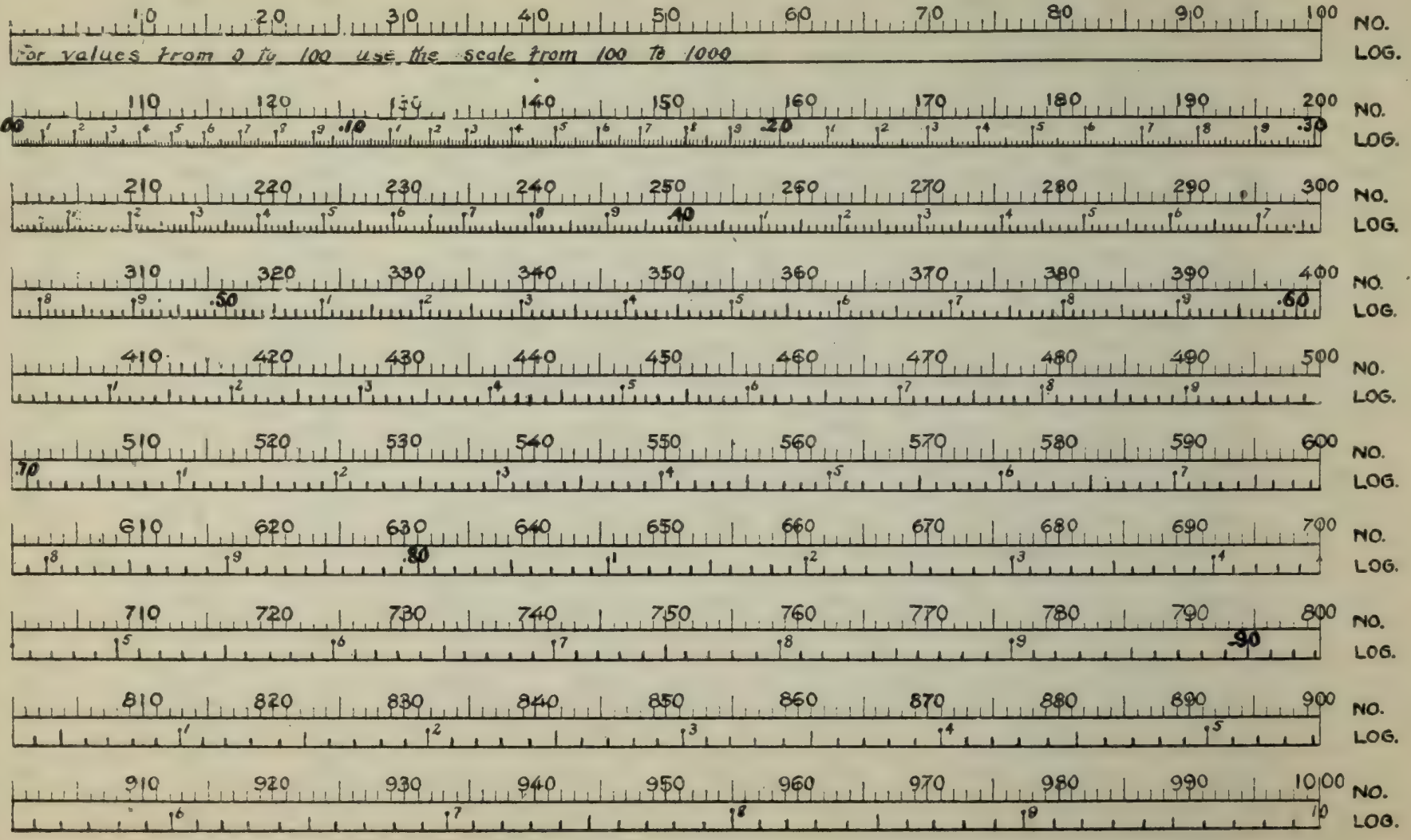
Square and Cube Roots of Numbers

Top scale is divided into UNITS. Square Root scale is divided into UNITS and TENTHS up to 14.1 and further divided into HUNDREDTHS beyond 14.1 Cube Root scale is divided into UNITS, TENTHS, and HUNDREDTHS beyond 3.



ALWAYS APPROXIMATE BETWEEN DIVISIONS ON THE BASIS OF 1/10 FOR NEXT FIGURE.

Logarithms of Numbers




Sines, Casines, Tangents, Cotangents (Natural)
ANGLE
SIN.
TAN.
1°
2°
3°
4°
5°
6°
7°
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9°
10°
11°
12°
13°
14°
15°
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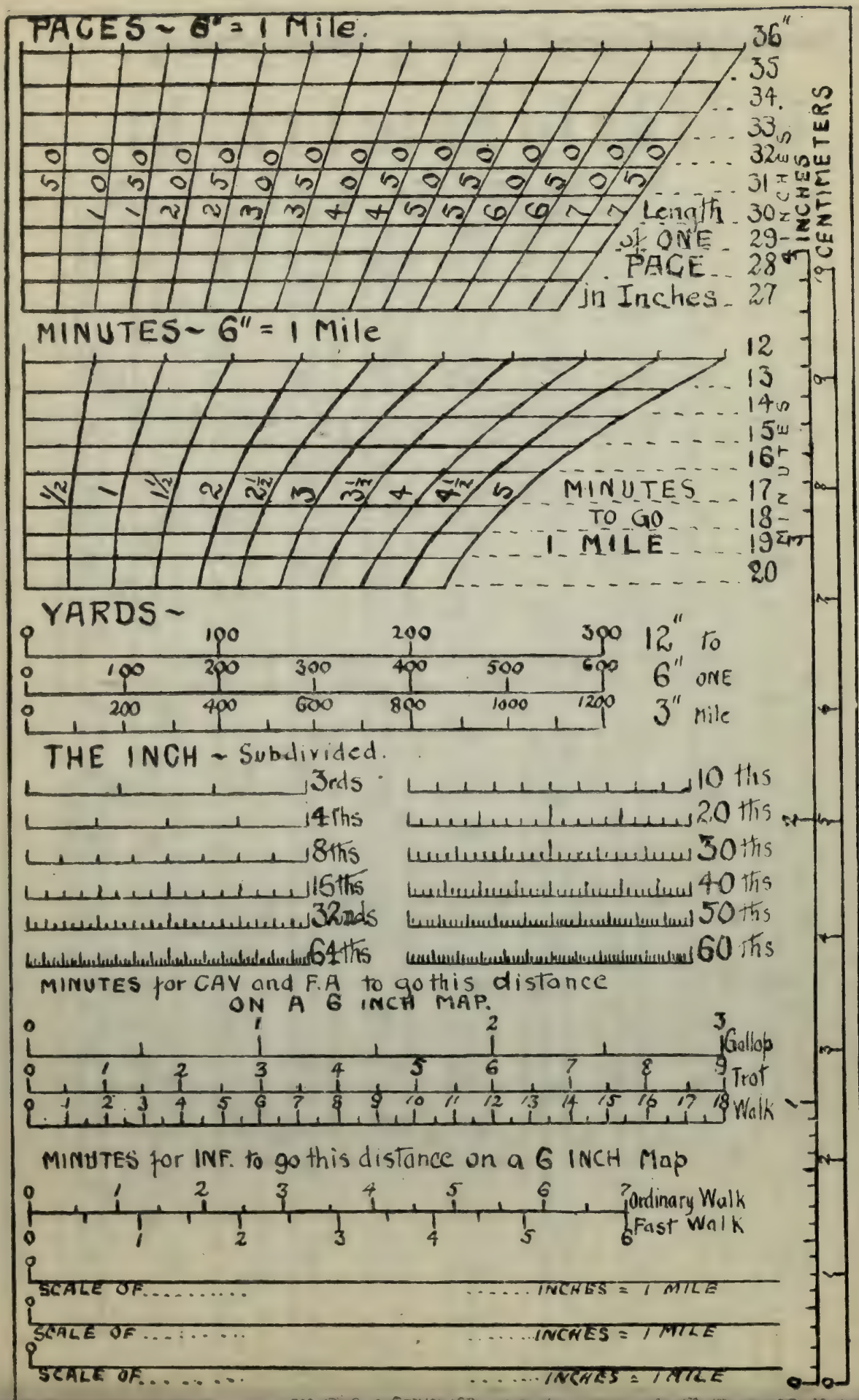
90°
91°
92°
93°
94°
95°
96°
97°
98°
99°
10'
20'
30'
40'
50'
60'
SINE OR TANGENT


PACES ~ 6" = 1 Mile.
50 100 150 200 250 300 350 400 450 500 550 600 650 700 750
1/2 1 1 1/2 2 2 1/2 3 3 1/2 4 4 1/2 5 5 1/2 6 6 1/2 7 7 1/2
Length of ONE PACE in Inches
36" 35 34 33 32 31 30 29 28 27
MINUTES ~ 6" = 1 Mile
1/2 1 1 1/2 2 2 1/2 3 3 1/2 4 4 1/2 5
MINUTES TO GO 1 MILE
12 13 14 15 16 17 18 19 20
YARDS ~
0 100 200 300
0 100 200 300 400 500 600
0 200 400 600 800 1000 1200
12" to 6" ONE 3" Mile
THE INCH ~ Subdivided.
3rds 4ths 8ths 15ths 32nds 64ths
10 ths 20 ths 30 ths 40 ths 50 ths 60 ths
MINUTES for CAV and F.A to go this distance ON A 6 INCH MAP.
0 1 2 3 Gallop
0 1 2 3 4 5 6 7 8 9 Trot
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 Walk
MINUTES for INF. to go this distance on a 6 INCH Map
0 1 2 3 4 5 6 7 Ordinary Walk
0 1 2 3 4 5 6 Fast Walk
SCALE OF..... ..... INCHES = 1 MILE
SCALE OF..... ..... INCHES = 1 MILE
SCALE OF..... ..... INCHES = 1 MILE
INCHES
CENTIMETERS

Capacity of a Cistern:—Square the mean diameter in feet × depth in feet × 5.875 = gallons; or × 0.1867 = barrels; or × 0.09325 = hogsheads. Cylindrical feet = diameter squared × depth.

Contents of a Barrel:—Square the mean diameter in inches × depth in inches × 0.0034 = gallons. 1 barrel contains 36 ale gallons, and 1 hogshead contains 54 ale gallons.

Wood:—Maximum tensile strength per square inch in tons; hickory, lancewood, 11; ash, beech, box, oak, spruce, 8; elm, cedar, 6; maple, pine, 5; walnut, larch, 4.

Corn on Cob:—Cubic feet × 0.45 will give number of bushels of shelled corn in space occupied by corn on cob; Cubic feet × 0.018 = number of bushels of corn on cob.

Number of cubic feet in a round log:—Add large and small end diameters in inches, divide by 6, square result, multiply by length in feet, divide by 36.

Number of board feet in a round log:—Subtract 4 inches from diameter of small end in inches, divide by 4, square result, multiply by length in feet. Or—Square the mean diameter in inches, subtract 60, divide by 2, multiply by length in feet, point off right hand figure.

Number of brick in a wall (close approximation):—Square feet of wall × number of brick thick, divide by 7.

Number of perch (stone) in a wall:—Cubic feet × 4, multiply by 0.01 and add this to result, move decimal point 2 places to left.

Seed to the Acre:—Wheat 2 bu.; barley 2 bu.; oats 4 bu.; rye 2 bu.; corn 2 bu.; timothy 24 qts.; red top 16 qts.; red clover 16 lbs.; white clover 4 lbs.; blue grass 15 lbs.

Cost of one mile barbed wire fence:—Including posts, steel wire, and labor, about $200.00 per mile.

Cylinders to measures:—D = diameter of cylinder and H = its height, then—Half pint, D = 2¼″, H = 3⅝″; Pint, D = 3½″, H = 3″; Quart, D = 3½″, H = 6″; Gallon, D = 7″, H = 6″; 2 Gallons, D = 7″, H = 12″; 8 Gallons, D = 14″, H = 12″; 10 Gallons, D = 14, H = 15″.

To regulate a watch:—Select any star (not planet) about 45° above horizon. Place a convenient peep sight and a vertical and a horizontal "cross hairs" some feet away. The star will cross the vertical hair exactly 3′ 55.91″ later each night.

Slopes to horizontal and vertical:—Any horizontal distance = slope distance × cosine of angle; any sloping distance = horizontal distance ÷ cosine of angle; any vertical distance = horizontal distance × tangent of angle, or = sloping distance × sine of angle.

Length of runs for engines:—Passenger engines carry fuel and water sufficient for about a 60-mile run; freight, half that much.

Air:—Allow minimum of 5 cu. ft. fresh air per minute, per man. Air enters a vacuum at rate of 1,157 feet per second.

Velocity of sound:—In air, about 1,100 feet per second; in water, about 4,400 feet per second.

Altitude of barometer:—Read at bottom (a) and at top (b), then altitude in feet = [55,000 (a — b)] ÷ (a + b).

Offsets in surveying:—Any offset in feet = 0.6667 × total distance in miles squared × natural tangent of latitude.

Thermometers:—5/9 (F° — 32) = C°; 4/9 (F° — 32) = R°; 9/5 C° + 32° = F°; 4/5 C° = R°; 9/4 R° + 32° = F°; 5/4 R° = C°.

Board Measure:—1 foot of board measure = 1 foot square and 1 inch thick or 144 cubic inches. 1 cubic foot = 12 feet B. M.

Value of 1° Latitude:—Equator, 68.7 miles; longitude 40°, 69 miles.

Measures:—1 Point = 1/72 inch; 1 Line = 1/12 inch; 1 Palm = 3″; 1 hand = 4″; 1 span = 9″; 1 fathom = 6 feet; 1 cable = 720 feet; 1 toise = 261½ cubic feet; 1 chaldron = 58.64 cu. ft.; 1 puncheon = 84 gallons; 1 tierce = 42 gallons; 1 struck bushel = 1.244 cu. ft.; 1 circular inch = circle of 1 inch diameter, hence 1 circular inch = 0.7854 sq. inches; 1 section of land = 640 acres = 1 square mile; 1 perch = 24¾ cu. ft.; 1 Gunters chain = 66 ft. = 4 rods = 100 links each 7.92″ long, 80 chains = 1 mile, 10 sq. chains = 1 acre; 1 milimeter = 1/25 of an inch (nearly);

1 centimeter is a full ⅜ inch; 1 meter is practically 3′ 3⅜″; 1 Russian verst = 3,500 feet; 1 Spanish vara = 32.8748 inches or 2′ 8⅞″; 1 legua = 5,000 varas; 1 barrel = 31½ gallons; 1 stone of lead or iron = 14 lbs.; 1 pig of lead or iron = 21½ stone; 20 articles = 1 score; 12 dozen = 1 gross; 12 gross = 1 great gross; 1 cord wood = 128 cu. ft.; 1 case = 60 pairs shoes.

Foreign Money:—Great Britain, 1 Pound = $4.8665; 1 shilling = $0.243325, 1 penny = $0.020277, 1 farthing = $0.00506927. Argentine Republic, 1 peso fuerte = $1.00. Austria, 1 *florin = $0.453; Belgium, 1 franc = $0.193; Bolivia, 1 dollar = $0.965; Brazil, 1 milreis = $0.545; British America, 1 dollar = $1.00; Central America, 1 *dollar = $0.918; Chili, 1 peso = $0.912; Cuba, 1 peso = $0.925; Ecuador, 1 *dollar = $0.918; Egypt, 1 pound (100 piasts) = $4.974; France, 1 franc = $0.193; Greece, 1 drachma = $0.193; German Empire, 1 mark = $0.238; India, 1 *rupee = $0.436; Italy, 1 lira = $0.193; Japan, 1 *yen = $0.997; Mexico, 1 *dollar = $0.909; Netherlands, 1 *florin = $0.385; Denmark, Sweden, Norway, 1 crown = $0.268; Paraguay, 1 peso = $1.00; Porto Rico, 1 peso =$0.925; Portugal, 1 mil = $1.08; Russia, 1 *rouble = $0.734; Spain, 1 peseta = $0.193; Switzerland, 1 franc = $0.193; Turkey, 1 piaster = $0.044; Columbia, 1 *peso = $0.918; Uraguay, 1 patacon = $0.949.

Note:—These are custom values; in some cases mint values vary constantly, and are marked by *.

Foreign Road Measures:—England, 1 mile = 1,760 yards; Austria, 1 mile = 8,297 yds.; Brazil, 1 league = 6,760 yds.; Denmark, 1 mul = 8,238 yds.; France, 1 kilometer = 1,093.6 yds.; Ireland, 1 mile = 2,240 yds.; Italy, 1 mile = 2,025 yds.; Mexico, 1 legua = 4,638 yds.; Norway, 1 mile = 12,182 yds.; Persia, 1 parasand = 6,076 yds.; Portugal, 1 league = 6,760 yds.; Prussia, 1 mile = 8,238 yds.; Russia, 1 verst = 1,167 yds.; Spain, 1 league = 7,416 yds.; Sweden, 1 mile = 11,700 yds.; Switzerland, 1 meile = 8,548 yds.; Scotland, 1 mile = 1,984 yds.

Foreign Weights and Measures:—Austria, 1 pfound = 1.235 lbs. avoir.; 1 eimer = 14.95 gals.; 1 nutze = 1.745 bu. China, 1 catty = 1.333 lbs. avoir.; 1 sei = 3.472 bu. Cuba, 1 libra = 1.0119 lbs. avoir.; 1 arroba = 4.1 gals.; 1 fanega = 3.124 bu. England, 1 pound = 1 lb. avoir.; 1 Imperial gal. = 1.2003 gals.; 1 Imp. bu. = 1.0315 bu. France, 1 kilo = 2.2043 lbs. avoir; 1 litre = 0.2642 gals.; 1 hectolitre = 2.838 bu. Japan, 1 monme = 3.858 lbs. avoir.; 1 masa = 0.459 gals. Mexico, 1 libra = 1.0119 lbs. avoir.; 1 frasco = 0.4 gal.; 1 fanega = 1.547 bu. Russia, 1 fuat = 1.097 lbs. avoir.; 1 vedro = 3.249 gals.; 1 chetviert = 5.956 bu. Turkey, 1 oke = 2.834 lbs. avoir.; 1 kilo = 1.001 bu.

Foreign Units of Length:—Austria, 1 fuss = 12.445 inches; Belgium, 1 elle = 39.371 inches; Brazil, 1 cubit = 25.98 inches; China, 1 chick = 14.1 inches; Denmark, 1 fod = 12.357 inches; Egypt, 1 derah = 25.49 inches; England, same as United States; Greece, 1 cubit = 18.0 inches; India, 1 cubit = 18.0 inches; Italy, 1 pie = 13.68 inches; Japan, 1 fan = 12 inches; Mexico, 1 pie = 11.28 inches; Norway, 1 fod = 12.353 inches; Persia, 1 arish = 38.27 inches; Portugal, 1 foot = 13.33 inches; Prussia, 1 fuss = 12.357 inches; Russia, 1 foot = 13.75 inches; Spain, 1 foot = 11.128 inches; Sweden, 1 foot = 33.384 inches; Turkey, 1 pic = 27.9 inches.

Foreign Land Measures:—Austria, 1 joch = 6,884 sq. yds.; France, 1 are = 119.6 sq. yds.; England, same as United States; Portugal, 1 yeira = 6,970 sq. yds.; Prussia, 1 morgen = 3,054 sq. yds., also another value, 6,786 sq. yds.; Russia, 1 deciatina = 13,067 sq. yds.; Spain, 1 fanegada = 7,682 sq. yds.; Sweden, 1 taunel'd = 5,872 sq. yds.; Switzerland, 1 faux = 7,855 sq. yds.

Value of 1 U. S. Mile in Foreign Countries:—1 Arabian mile = 1 mile 386 yds.; 1 Austrian post mile = 4 miles 1,257 yds.; 1 Belgian kilometer = 1,094 yds.; 1 Chinese li = 609 yds.; 1 Danish mile = 4 miles 1,198 yds.; 1 French kilometer = 1,094 yds.; 1 German metric mile = 1,640 yds.; 1 Italian mile = 1 mile 265 yds.; 1 Netherlands kilometer = 1,094 yds.; 1 Norwegian mile = 6 miles 1,622 yds.; 1 Persian parasang = 3 miles 796 yds.; 1 Portuguese mile = 1 mile 490 yds.; 1 Russian verst = 1,167 yds.; 1 Siamese roening = 2 miles 684 yds.; 1 Spanish mile =

1,503 yds.; 1 Turkish berri = 1 mile 67 yds.

Odometers:—First value is diameter of wheel in inches, second value is revolutions per mile for that wheel: 36″, 560.2; 37″, 545.1; 38″, 530.7; 39″, 517.1; 40″, 504.2; 41″, 491.1; 42″, 480.2; 43″, 469.0; 44″, 458.4; 45″, 448.2; 46″, 438.4; 47″, 429.1; 48″, 420.2. Place odometer on **front** wheel.

Boxes:—Best size for transportation: Wagon—38″ x 19″ x 15″ outside. Pack—30″ x 19″ x 15″ outside.

Vernier:—Direct (reading from 0 forward), 9 divisions on limb, 10 divisions on vernier. Retrograde, 11 divisions on limb, 10 divisions on vernier. To read any vernier, note value of last scale division passed over by the zero of vernier and to it add the "least count" multiplied by the number of the coincident of the vernier division. Value of "least count" obtained by dividing value of one division of the limb by the number of divisions of the vernier.

Scales of Maps:—The scale of any military map × its contour interval = 60. Road sketch, 3″ = 1 mile; position sketch, 6″ = 1 mile.

To find the Day of the Week:—Divide last 2 figures of year by 4 and disregard any remainder; add this quotient to the last two figures; add day of month; add **month factor** for that month. Now for 1700 add 2, for 1800 no change, for 1900 subtract 2; divide by 7 and the **remainder** is the **day factor. Month factors:**—January, 3; February, 6; March, 6; April, 2; May, 4; June, 0; July, 2; August, 5; September, 0; October, 3; November, 6; December, 1. **Day factors:**—Sunday, 1; Monday, 2; Tuesday, 3; Wednesday, 4; Thursday, 5; Friday, 6; Saturday, 0. Example:—August 6, 1917: 17 ÷ 4 = 4; 17 + 4 = 21 + 6 (day of month) = 27 + 5 (month factor) = 32 — (for 1900) 2 = 30 ÷ 7 = 4 and 2 over. 2 is the day factor for Monday.

To make a "one second" pendulum:—Suspend a pebble by a thread, distance from **center** of pebble to pivot of suspension = 39″. To make an X second pendulum, length of pendulum in inches = $\frac{(X)^2}{375}$. A cartridge on a 10-in. string will swing to beat ½ seconds (closely).

To ascertain the rate a train travels:—Count the clicks for 20 seconds, which equals the train's rate in miles per hour.

Effect of Wind:—Where f = force in lbs. per sq. inch, then velocity in miles per hour = $\sqrt{200\,f}$. Allow for wind pressure of 16 lbs. per sq. foot on roofs.

Safe thickness of Ice:—Men, single file, 2 inches; cavalry and light vehicles, 5 inches; field guns and wagons, 6 inches; heavy field guns and average motor trucks, 10 inches; any load drawn by animals, also heavy motor trucks, 12 inches.

Effective Ranges in yards:—Rifle, to 1,200 yards; light artillery, to 3,500 yards; heavy field artillery, to 4,000 yards; sea coast mortars, to 12,000 yards; guns of large calibre, about 20,000 yards.

Square Box Measure:—Box 24″ x 16″ square and 28″ deep contains 1 barrel, or 5 bushels. Box 24″ x 16″ square and 14″ deep contains ½ barrel. Box 16″ x 16¾″ square and 8″ deep will contain 1 bushel. Box 12″ x 11¼″ square and 8″ deep will contain ½ bushel. Box 8¼″ x 8¼″ square and 8″ deep will contain 1 peck. Box 8¼″ x 8¼″ square and 4″ deep will contain 1 gallon. Box 8¼″ x 4¼″ square and 4″ deep will contain ½ gallon. Box 4″ x 4¼″ square and 4″ deep will contain 1 quart.

Blue Print Solution:—Solution A—Citrate of iron and ammonia 2 ozs., water 8 ozs.; Solution B—Red prussiate of potash 2 ozs., water 8 ozs. For use to sensitize paper, mix 4 parts A with 3 parts B.

Tracing Paper Solution:—½ oz. gum mastic in a bottle holding 6 ozs. best spirits of turpentine; shake day by day till dissolved. Apply with a brush and hang up to dry.

To copy drawings:—217 grs. gum arabic, 70 grs. citric acid, 135 grs. iron chloride, ¼ pint water. Give paper 2 coatings, print in usual man-

ner, immerse in bath of yellow prussiate of potash, or of nitrate of silver. Wash in water slightly acidified with sulphuric or hydrochloric acid.

To trace drawings or maps:—Soak paper upon which the tracing is to be made with a little benzine on a cotton pad. This paper will take India ink, water colors, or pencil.

Hectograph:—For a dish 7" x 11", glue 3 ozs.. glycerine 15 ozs., kaolin or baric sulphate ¾ oz., water 1¼ ozs. Or (good hektograph) gelatine 4 ozs., glycerine 15 fl. ozs., carbolic acid ½ fl. oz., water 15 ozs. Add water to gelatine and allow to soak until mass is softened, then heat until dissolved and until water is evaporated. The acid is added carefully before cooling sets in.

Colored Inks:—70 parts water, 1 part methyl violet added to water, 10 parts acetic acid added last. Blue or green may be made by using methyl blue (or green), and red, by using acid fuchsin, instead of methyl violet.

Ink Eradicator:—No. 1 bottle: Sodium carbonate 10 grams, chlorinated lime 8 grams, enough water to make 100 parts (c c). No. 2 bottle: 6% watery solution acetic acid.

Hektograph Ink:—Concentrated solution of Paris violet. To remove old copy from pad, add a little muriatic acid to water.

Ink for Stamp-pads:—Black—16 parts boiled linseed oil varnish, 6 parts finest lamp black, 2 to 5 parts iron perchloride. Dilute with ⅛ the quantity of boiled oil varnish. **Blue**—Aniline blue, water solution, 3 parts; water 10 parts; pyrdigneous acid 10 parts; alcohol 10 parts; glycerine 70 parts.

To remove old paint or varnish:—Mix equal parts (by measure) of wood alcohol and benzine. Apply with brush, let get soft, scrape off.

To remove rust from steel:—½ oz. cyanide of potassium, ½ oz. castile soap, 1 oz. whiting, enough water to form paste. First wash the steel in ½ oz. cyanide of potassium in 2 ozs. water.

To preserve steel from rust:—1 part caoutchoue, 16 parts turpentine, dissolve with gentle heat, then add 8 parts boiled oil. Apply like varnish. Remove with turpentine.

Waterproofing Canvas:—1 gal. raw linseed oil, 12 ozs. beeswax, 1 lb. white lead, 12 ozs. common resin. Boil and stir while boiling. Wet under side of canvas with water, then apply warm mixture to upper side of canvas. **Cloth**—Spread cloth on table, wrong side up. Rub this wrong side with pure beeswax free from grease till it presents an even, whitish or grayish hue. Pass hot iron over cloth and brush same while warm. Very effective; keeps out water but not air.

Glue to resist moisture:—1 lb. glue melted in 2 quarts skim milk.

To Blacken Gun Sights:—Gas black ½ dram; methyl alcohol 2 fl. drams; spirit varnish 2 fl. drams.

To "Blue" Steel:—Dissolve 4½ ozs. hyposulphite of soda in 1 quart water; also 1¼ ozs. acetate of lead in 1 quart water; mix solutions and bring to boil in porcelain dish. Clean steel of all grease, oil, etc.; warm the steel, smear with the hot solution; when color develops wash and wipe dry; finish with boiled linseed oil.

Distance by sound:—Range in yards = seconds × 400.

Difference in elevation due to curvature of earth:—Difference in elevation in feet = 2/3 of the square of the distance in **miles.**

Distance to visible horizon:—Distance in miles = square root of the height of observer above water in **feet** × 1.225.

Hour gradations of a watch are 30° apart and the minutes are 6°.

A Copper Cent is ¾ inch in diameter.

Bridging carried by ponton companies:—Light (3 divisions), 552 feet; heavy (6 divisions), 1,350 feet.

Limits of radio sets:—Pack set, 30 miles; wagon wireless set, 200 miles.

Wire carried on reel carts:—5 miles field wire, and 1½ miles buzzer wire.

Width of rear sight leaf in mils:—The rear sight leaf raised in the position of aim is approximately 50 mils, or 1/20 of the range at all ranges.

Finger measurement of sectors:—For designating and measuring sectors of fire in attack and defense, face the sector, arm horizontally extended toward sector, fingers joined and vertical, at height of eyes; sight along second-joint-line of fingers to sector and measure its width in finger breadths. Average finger breadth is 3 yds. per 100 yds. of range, or 30 mils.

To Paint Galvanized Iron:—First paint the surface with a solution of copper sulphate ("blue stone" in water), then the paint will adhere, otherwise it may not.

Acre:—For rough estimate consider 70 yds. × 70 yds. = 1 acre.

Rate of Flow, Streams:—Consider 0.7 × feet per second = miles per hour.

Roads:—Consider 1 cubic yard crushed stone will cover 12 square yards of road; and that 1 mile of road 18 feet wide requires 733 cubic yards crushed stone.

Supplies, Calculations for:—Corn—Consider 1 cubic yard = 1,000 lbs., and 1 acre = 1 ton; **Grass**—Consider 1 acre = 1 to 3 tons of hay when cut; **Hay**—Rectangular rick with gable roof:—Height × breadth × length × 0.91 = tons; Circular rick, apex roof:—Diameter × [height to eaves + ½ height from eaves to apex] (all in yards) × 0.57 = tons; **Straw**—Same as for Hay, but use for multipliers, Rectangular rick, 0.0625, and for Circular rick, 0.393. **Water**—Breadth of stream × depth × velocity (all in feet) × 900 = number of men which stream will supply for 24 hours. **Wells**—Area × depth (all in feet) × 6.23 = gallons.

Scout Signals:—(Author's suggestions only) **Reinforce me**—Arm swung from rear, over shoulder, to front. **Close in**, or **Close up**—Arms extended latterly and at once swung forward to opposite center of body. **Extend**, or **Open out**—Extend arms forward in front of center of body and at once swing them apart latterally. **Enemy in sight**—Having no rifle, clasp hands overhead, elbows latterally extended, few—once, many—several times quickly. **Am short of ammunition**—Rifle perpendicular, butt uppermost.

DEFLECTION OF THE RIGHT PIECE, AND ANGLE OF SITE

Deflection of Right piece:—A is the angle measured at the B.C. station from the Aiming Point to the Target. Ascertain paralax of target by dividing the perpendicular distance in yards from B.C. station to line of fire by the number of THOUSANDS of yards in range; the result will be in mils.

In a similar manner ascertain the paralax of the Aiming Point, using the distance to that point and the perpendicular distance from B.C. station to the line Guns—Aiming Point.

Apply to A the angles thus obtained as follows:—If you are on the RIGHT of the GUNS as you look at the Target SUBTRACT the Target paralax; if on the LEFT of the GUNS ADD the paralax. The REVERSE applies with respect to the AIMING POINT.

Angle of Site:—Ascertain the difference in LEVEL in yards between Observation Station and Guns. Divide this result by the number of THOUSANDS of yards in range from the Guns to the Target, which will be the angular correction in mils to be applied to the Angle of Site of the Target as read at the Observation Station.

If the station is ABOVE the Guns ADD the correction; if BELOW the Guns SUBTRACT the correction.

The above, though not EXACT is sufficiently close.

Figure 1:—As you look at the TARGET, with B.C. on the LEFT of the GUNS add offset of target. As you look at the AIMING POINT, with B.C. on the LEFT of the GUNS, subtract offset of aiming point.

Angle A = 1155; Tp = + 215; Pp = — 215; Hence D = 1155.

Figure 2:—Is the Correction for Obliquity.

Figure 3:—As you look at the TARGET, with B.C. on the RIGHT of the GUNS, subtract offset of target. As you look at the AIMING POINT, with B.C. on the RIGHT of the GUNS, add offset of the Aiming Point.

Angle A = 890; Tp = — 285; Pp = + 215; Hence D = 820.

Figure 4:—As you look at the TARGET, with B.C. on the RIGHT of the GUNS subtract offset of Target. As you look at the AIMING POINT, with B.C. on the LEFT of the GUNS, subtract offset of the Aiming Point.

Angle A measured at B.C. station = 4075; Tp = — 375; Pp = — 500; Hence D = 3200.

Figure 5:—As you look at the TARGET, with B.C. on the LEFT of the GUNS, add offset for target. As you look at the AIMING POINT with B.C. on the RIGHT of the GUNS, add offset of Aiming Point.

Angle A measured at B.C. station = 3020; Tp = + 320; Pp = + 320; Hence D = 3660.

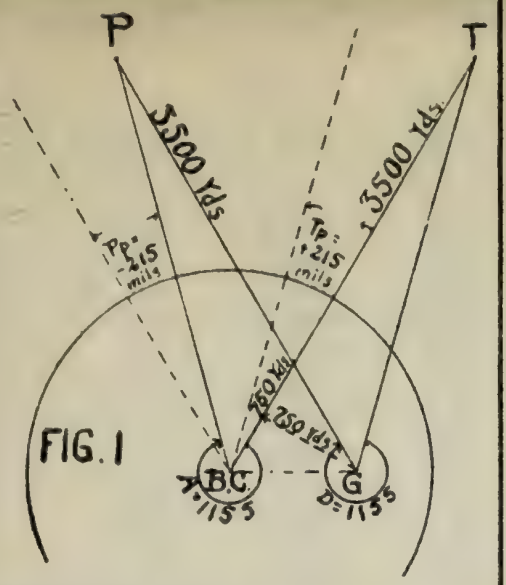


FIG. 1

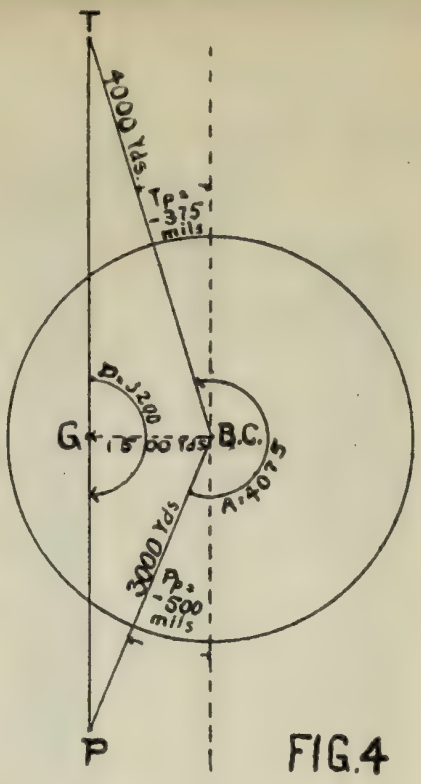


FIG. 4

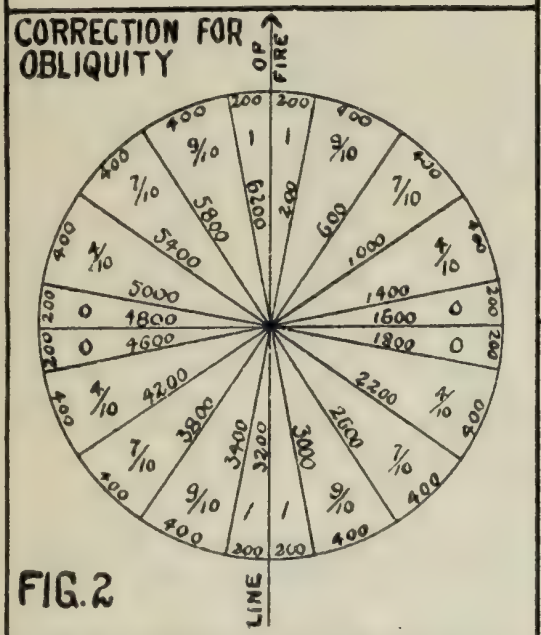


FIG. 2

A.P. FRONT ; B.C. RIGHT

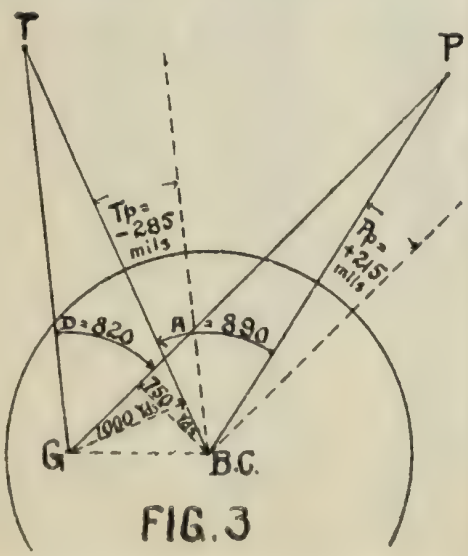


FIG. 3

A.P. REAR ; B.C. LEFT

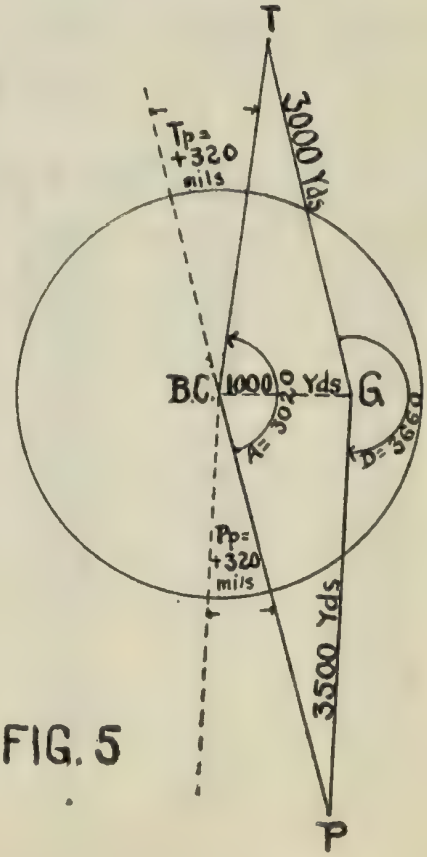


FIG. 5

3 Inch Gun

Range Yds.	Dept. Mils	Range Yds.	Dept. Mils	Range Yds.	Dept. Mils	Range Yds.	Dept. Mils
100	2	2,100	56	4,100	146	6,100	275
200	3	2,200	60	4,200	151	6,200	283
300	5	2,300	64	4,300	157	6,300	290
400	7	2,400	68	4,400	163	6,400	298
500	9	2,500	72	4,500	168	6,500	306
600	11	2,600	76	4,600	174	6,600	314
700	13	2,700	80	4,700	180	6,700	323
800	16	2,800	84	4,800	187	6,800	331
900	18	2,900	88	4,900	193	6,900	339
1,000	21	3,000	92	5,000	199	7,000	348
1,100	24	3,100	97	5,100	205	7,100	357
1,200	27	3,200	101	5,200	212	7,200	365
1,300	30	3,300	106	5,300	218	7,300	375
1,400	33	3,400	110	5,400	225	7,400	384
1,500	36	3,500	115	5,500	232	7,500	393
1,600	39	3,600	120	5,600	239	7,600	402
1,700	42	3,700	125	5,700	246	7,700	412
1,800	45	3,800	130	5,800	253	7,800	422
1,900	49	3,900	135	5,900	260	7,900	432
2,000	52	4,000	140	6,000	267	8,000	442

Note:—The distance in yards to the maximum ordinate is 0.55 times the range. Angle of Fall is (approx.) 1½ times Angle of Departure.

4.7 Inch Gun

Range Yds.	Dept. Mils	Range Yds.	Dept. Mils	Range Yds.	Dept. Mils	Range Yds.	Dept. Mils
100	1	2,900	63	5,700	163	8,500	299
200	3	3,000	66	5,800	168	8,600	304
300	5	3,100	69	5,900	172	8,700	310
400	7	3,200	72	6,000	177	8,800	315
500	8	3,300	75	6,100	181	8,900	320
600	10	3,400	78	6,200	186	9,000	326
700	12	3,500	81	6,300	191	9,100	332
800	14	3,600	84	6,400	196	9,200	338
900	16	3,700	87	6,500	200	9,300	344
1,000	18	3,800	91	6,600	205	9,400	349
1,100	20	3,900	94	6,700	209	9,500	355
1,200	23	4,000	97	6,800	214	9,600	362
1,300	25	4,100	101	6,900	219	9,700	368
1,400	27	4,200	104	7,000	223	9,800	375
1,500	29	4,300	108	7,100	228	9,900	381
1,600	31	4,400	111	7,200	233	10,000	388
1,700	33	4,500	115	7,300	237	10,100	395
1,800	36	4,600	119	7,400	242	10,200	402
1,900	38	4,700	123	7,500	247	10,300	409
2,000	40	4,800	126	7,600	252	10,400	416
2,100	43	4,900	130	7,700	257	10,500	424
2,200	45	5,000	134	7,800	262	10,600	431
2,300	47	5,100	138	7,900	267	10,700	439
2,400	50	5,200	142	8,000	272	10,800	447
2,500	52	5,300	146	8,100	277	10,900	455
2,600	55	5,400	150	8,200	283	11,000	463
2,700	58	5,500	154	8,300	288		
2,800	60	5,600	159	8,400	293		

Note:—The distance in yards to the maximum ordinate is 0.54 times the range. Angle of Fall is (approx.) 1½ times Angle of Departure.

FRIED:—Peel and cut into slices about ¼ inch thick two medium sized potatoes (about ½ lb.) and place in mess pan containing grease remaining after frying bacon. Add water to half cover potatoes, cover with lid and let come to boil for 20 minutes. Remove cover and dry potatoes. Add salt and pepper. Note:—Place cover bottom side up over potatoes, place bacon already cooked on cover to keep it hot.

BOILED:—Peel and cut into 1½ inch cubes two medium sized potatoes. Place in mess pan ¾ full of water. Cover with lid and let boil 20 minutes. Done when easily penetrated by sharp stick. Pour off water and let dry for a minute or so over hot coals.

BAKED:—Lay potatoes in hot coals, cover with ashes, leave for 40 minutes.

Rice, Boiled:—4 heaping spoonfuls in 2/3 cup of **boiling** water. Boil 20 minutes. Add 2 pinches salt and, if desired, 1 spoonful sugar. Drain off the water.

Cornmeal; Hominy; Oatmeal; Corn, Dried, Sweet:—Same as for RICE except only 1/3 cup of water.

Beans, Lima:—4 heaping spoonfuls in 2/3 cup of **cold** water. Boil 2 to 3 hours. Add 1 pinch salt. When done beans should be whole but soft. Add 1 slice bacon ½ hour before done. Add water as required.

Beans, Chili; Beans, Issue; Frijoles; Peas (dried green or coarse split); **Hominy:**—Same as for BEANS, LIMA, except time is from 3 to 4 hours.

Tomatoes, Canned:—Note:—One 2-lb. can is enough for 5 men. (a) Pour into mess pan 1 man's allowance. Add 2 large hardtacks broken into small pieces and let come to boil. Add pinch of salt and ¼ spoonful of sugar. (b) Having grease from bacon, pour tomatoes into mess pan. Add 2 broken hardtacks. Set over brisk fire and let come to boil.

Onions, Fried:—Same as POTATOES, FRIED.

Meats.

BACON, FRIED:—Place slices in mess pan with about ½ inch of cold water. Let come to boil. Pour off water. Fry over brisk fire, turning bacon once to brown it. Remove bacon to lid of mess pan. Use grease for frying potatoes.

FRESH MEAT, FRIED:—Use 1 spoonful lard or fat in mess pan. Let come to smoking temperature. Put in meat about ½ inch thick. Fry for one minute. Turn and fry briskly. Salt and pepper to taste.

FRESH MEAT, TO BROIL:—Slice 1 inch thick, about as large as a hand. Use sharpened stick three feet long and weave point of stick through steak several times. Hold over brisk coals on windward side of fire. Turn frequently, allow to brown nicely. Salt and pepper to taste. Use meat with considerable fat.

FRESH MEAT, TO STEW:—Cut into 1 inch cubes. Fill cup 1/3 full of meat and cover with about 1 inch of water. Let boil or simmer for one hour. Add vegetables (carrots, turnips, cabbage, etc.) cut into small chunks soon after the meat is put on to boil. Add potatoes, onions, and other vegetables when meat is half done. Amount of vegetables equals the amount of meat. Salt and pepper to taste. Applies to all fresh meat fowls. Fresh fish can be handled in similar manner, except it is cooked quicker and only potatoes, onions, and canned corn are used with it; a slice of bacon would improve the flavor.

Hot Breads.

FLAP JACK:—Thoroughly mix 6 spoonfuls of flour with 1 spoonful baking powder, or dry mix in a large pan before issue at the rate of 25 lbs. flour to 3 ½-lb. cans of baking powder for 100 men. Add sufficient cold water to make a batter that will drip freely from the spoon. Add one pinch of salt. Pour into mess pan containing grease from fried bacon, or a spoonful of fat, and place over coals of sufficient heat to enable flap jack to be turned in 5 minutes. Fry from 5 to 7 minutes longer.

HOE CAKE:—Same as for FLAP JACK, using corn meal instead of flour.

Coffee:—1 heaping spoonful in 2/3 cup of **boiling** water. Boil 5 minutes. Add 1 spoonful sugar, stirring well. Let simmer 10 minutes. Settle by adding a little cold water. Let stand 2 minutes.

Cocoa:—1 heaping spoonful cocoa in 2/3 cup of boiling water. Boil 5 minutes. Add 1½ spoonful sugar, stirring well.

Tea:—½ level spoonful in one cup of boiling water. Allow to steep (off the fire) 2 or 3 minutes.

USE A SHARP PENCIL

CALL 7 | TO Comdg. Officer 8th Cav.

AT Crossroads

SIGN 22 | FROM C. O. Troop F 8th Cav.

AT Hill 107

COMBAT MESSAGE

Strong patrol of enemy one mile east of Watterman Farm, moving South on Kief Laymon Road.

A. S. P.

SAMPLE MESSAGE:—

Writer—Does not enter the call, sign, nor data at bottom of blank. He signs his initials. May even omit all at top of blank except "To."

Sending Signalist—Calls "7" and signs "22"; does **not** send words after "To," "From," or the "At's." **Enters** data at bottom of blank but does not **send** it. Does **not** send initials.

Receiving Signalist—Enters all shown on blank except initials, identifies "To" by the CALL, adds location of recipient as he knows it to be; identifies "From" by the SIGN, adds location of sending signalist. Date is March (3rd mo.) 28th, 1917, 3:10 P. M. Check is 16 words.

For full and complete description of this type of message, see "Flag Signalist's Handbook," Banta Pub. Co.

3/28/17 3:10 A.M. P.M. CHECK 1-16

USE A SHARP PENCIL

CALL | TO

AT

SIGN | FROM

AT

COMBAT MESSAGE

/ / /

A.M. / P.M. | CHECK

USE A SHARP PENCIL

CALL | TO

AT

SIGN | FROM

AT

COMBAT MESSAGE

A.M. / P.M. | CHECK

USE A SHARP PENCIL

CALL | TO

AT

SIGN | FROM

AT

COMBAT MESSAGE

A.M. / P.M. | CHECK